

# PCMDI Analysis of Candidate Atmospheric Models for CCSM

*M. F. Wehner, K. Taylor, C. Doutriaux, K. AchutaRao, P.  
Gleckler, J. Hnilo, J. Boyle*

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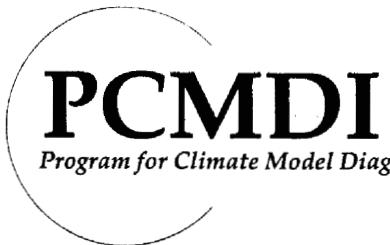
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## **PCMDI Analysis of Candidate Atmospheric Models for CCSM**

**Michael F. Wehner, Karl Taylor, Charles Doutriaux,  
Krishna AchutaRao, Peter Gleckler,  
Justin Hnilo, and James Boyle**

**Program for Climate Model Diagnosis and Intercomparison  
Lawrence Livermore National Laboratory  
Livermore, CA**

**December 13, 2000**

**PROGRAM FOR CLIMATE MODEL DIAGNOSIS AND INTERCOMPARISON  
UNIVERSITY OF CALIFORNIA, LAWRENCE LIVERMORE NATIONAL LABORATORY  
LIVERMORE, CA 94550**

## **Abstract**

This report is intended to give a summary analysis of the candidate model configurations under consideration by NCAR for the atmospheric component of next version of the Community Climate System Model (CCSM). Intercomparison results are presented for each of the models available prior to the Atmospheric Model Working Group (AMWG) meeting, December 12-14, 2000. We present four types of figures in this report. The traditional methods of viewing zonal mean surface fields, latitude-longitude maps and zonal mean latitude-height cross sections are straightforward. In each of these cases, we present DJF and JJA climatological averages and a difference from an observational or reanalysis data set. The fourth method of analyzing the candidates' model performance involves the use of "performance portraits" and is explained in detail on following pages.

As stated by NCAR and the AMWG, the information included in this report should be considered proprietary to NCAR and is not to be cited, consistent with the disclaimer on the AMWG password protected web pages.

We deliberately have deferred our conclusions in this printed report to our presentation. Rather, we encourage you to draw your own conclusions based on these figures and other information made available at the AMWG meeting.

Michael Wehner  
Program for Climate Model Diagnosis and Intercomparison  
December 13, 2000

## List of candidate model names

**CCM\_3.5.27\_AMIP** standard 18 level model released as CCM version 3.6.

**CCM\_3.9.11\_AMIP** standard 30 level model released as CCM version 3.10.

**SDL\_AMIP** CCM 3.10 physics with semi-lagrangian dynamics.

**LR\_AMIP** CCM 3.10 with Lin-Rood dynamics

**RAS\_AMIP** CCM 3.10 physics with relaxed Arakawa-Schubert convection.

**CSU\_AMIP** Colorado State University Arakawa-Schubert convection scheme

**TRIG\_AMIP** CCM 3.10 using Zhang-McFarlane convection with physical triggers.

**ZHANG** Zhang-McFarlane convection with modified closure

**VDT** CCM 3.10 physics with vertical diffusion of dry static energy.

**H2OABS** CCM 3.10 using new H<sub>2</sub>O longwave absorption parameterization.

**R1UP** CCM 3.10 standard model using a 1-digit reduced grid. (not available)

## **Climate variables analyzed in this study**

# Reference Data Sets used by PCMDI in the evaluation of CAM candidate models

The following page is excerpted from Mike Fiorino's page:

<http://www-pcmdi.llnl.gov/obs/pods/mo/obs.mo.source.htm> .

A heuristic quality rating is given based on a characterization of quality used in the NCEP reanalysis project. The table below describes the NCEP rating scheme.

## Data Quality Scale

A	strong influence of observational data; most reliable
A-	strong influence of observational data; but significant model component, possibly a model of lesser quality than in A
B+	direct influence of observational data, but significant model component
B	direct influence of observational data, but strong model component
B-	direct influence of observational data, but large component from an older and/or lower quality model
C+	indirect influence of observational data; all model, but a model of higher quality than C
C	no direct influence of observational data; all model
C-	no direct influence of observational data; all model and of lesser quality than C
D	well-observed fixed fields
D-	less quality observed fixed fields

## Key to Data Set Description Table

Data Set Title	Description
Time Type:	time series or climatology
Frequency	Observing frequencies; mo = monthly; 6h = 6 hourly
Time Period	Period in the time series or in the climatology, either in YYYY->YYYY or YYMM->YYMM format where YYYY is the four-digit year and YYMM is a two digit year/month
Quality Rate	Adaptation of rating used in the NCEP reanalysis
Comment:	Known strengths & weakness; miscellaneous information
Citation:	How the data set is cited in a paper
Reference:	Reference
Web Resource:	URL (clickable)

<b>NCEP CMAP Precipitation (Xie &amp; Arkin)</b>	NCEP Xie and Arkin CPC (Climate Prediction Center) Merged Analysis of Precipitation (CMAP)
Time Type:	time series
Frequency	mo
Time Period:	7901->9612
Quality Rating	A-
Comment:	A merging of all sources of precipitation data including satellite and land based observations; the greatest observational content
Citation:	Xie and Arkin 1996 and 1997
Reference(s);	Xie, P. and P. Arkin, 1996: Analyses of global monthly precipitation using gauge observations, satellite estimates, and numerical model predictions. <i>J. Climate</i> , <b>9</b> , 840-858. Xie, P. and P. Arkin, 1997: Global precipitation: A 17-year monthly analysis based on gauge observations, satellite estimates, and numerical model outputs. <i>Bull. Amer. Meteor. Soc.</i> , <b>78</b> , 2539-2558.
Web Resource	<a href="ftp://ftp.ncep.noaa.gov/precip/cmap">ftp://ftp.ncep.noaa.gov/precip/cmap</a>

<b>ERBE</b>	Earth Radiation Budget Experiment (ERBE) data set
Time Type:	time series
Frequency	mo
Time Period:	8502->8905
Quality Rating	B
Comment:	The most accurate measurement of top of the atmosphere short and long wave, and clear and cloudy radiation; limited time period
Citation:	Barkstrom et al. 1989
Reference(s);	Barkstrom, B.R., E. Harrison, G. Smith, R. Green, J. Kibler, R. Cess, and ERAB Science Team, 1989: Earth Radiation Budget Experiment (ERBE) archival and April 1985 results. <i>Bull. Amer. Meteor. Soc.</i> , <b>70</b> , 1254-1262.
Web Resource	<a href="http://asd-www.larc.nasa.gov/erbe/ASDerbe.html">http://asd-www.larc.nasa.gov/erbe/ASDerbe.html</a>

<b>ISCCP C2</b>	International Satellite Cloud Climatology Project (ISCCP) C2 data set
Time Type:	time series
Frequency	mo
Time Period:	8307->9012
Quality Rating	B

Comment:	Satellite-sensed cloud properties; best coverage for the AMIP I decade; direct comparison with models ambiguous
Citation:	Rossow et al. 1991
Reference(s);	Rossow, W.B., L.C. Garder, P.J. Lu, and A.W. Walker, 1991: International satellite cloud climatology project (ISCCP) documentation of cloud data. WMO/TD-No. 266. World Meteorological Organization, 76 pp plus appendices. ( <a href="http://isccp.giss.noaa.gov/documents.html">http://isccp.giss.noaa.gov/documents.html</a> )
Web Resource	<a href="http://isccp.giss.nasa.gov/isccp.html">http://isccp.giss.nasa.gov/isccp.html</a>

<b>ERA-15 : ECMWF Reanalysis</b>	ECMWF 15-year ReAnalysis (ERA-15)
Time Type:	time series
Frequency	mo, 6h
Time Period:	7901->9402
Quality Rating	A -> C
Comment:	Highest resolution reanalysis with direct assimilation of satellite radiance data
Citation:	Gibson et al. 1997
Reference(s);	Gibson, J.K., P. Kallberg, S. Uppala, A. Hernandez, A. Nomura, E. Serrano, 1997: ERA Description. ECMWF Re-Analysis Project Report Series, No. 1, 72 pp. European Centre for Medium-Range Weather Forecast, RG2 9AX, Reading, UK.
Web Resource	<a href="http://www.ecmwf.int/data/reanalysis.html">http://www.ecmwf.int/data/reanalysis.html</a>

<b>UWM COADS Flux Climo</b>	Univ. of Wisconsin at Madison (UWM) COADS flux climatology
Time Type:	climatology
Frequency	mo
Time Period:	1945->89
Quality Rating	A- -> C-
Comment:	The best COADS-based flux climatology -- most observations, fluxes calculated from observations before analysis with corrections to insure hydrologic balance
Citation:	da Silva et al. 1994abcde and Young-Molling et al, 1995
Reference(s);	da Silva, A.M., C. C. Young and S. Levitus, 1994a: Atlas of Surface Marine Data 1994, Volume 1: Algorithms and Procedures. NOAA Atlas NESDIS 6, U.S. Department of Commerce, NOAA, NESDIS. da Silva, A.M., C. C. Young and S. Levitus, 1994b: Atlas of Surface Marine Data 1994, Volume 2: Anomalies of Directly Observed Quantities. NOAA Atlas NESDIS 7, U.S. Department of Commerce, NOAA, NESDIS. da Silva, A.M., C. C. Young and S. Levitus, 1994c: Atlas of Surface Marine Data 1994, Volume 3: Anomalies of Heat and Momentum Fluxes. NOAA Atlas NESDI

	<p>8, U.S. Department of Commerce, NOAA, NESDIS.</p> <p>da Silva, A.M., C. C. Young and S. Levitus, 1994d: Atlas of Surface Marine Data 1994, Volume 4: Anomalies of Fresh Water Fluxes. NOAA Atlas NESDIS 9, U.S. Department of Commerce, NOAA, NESDIS.</p> <p>da Silva, A.M., C.C. Young and S. Levitus, 1994e: Atlas of Surface Marine Data 1994, Volume 5: Anomalies of Miscellaneous Derived Quantities. NOAA Atlas NESDIS 10, U.S. Department of Commerce, NOAA, NESDIS. In press.</p> <p>Young-Molling, C.C., A. M. da Silva and S. Levitus, 1995: Atlas of Surface Marine Data 1994, Volume 6: Heat Flux Sensitivity to Sea Surface Temperature. NOAA Atlas NESDIS , U.S. Department of Commerce, NOAA, NESDIS. In preparation</p>
Web Resource	<a href="ftp://niteroi.gsfc.nasa.gov/pub/uwm_coads/1x1/data/clm/README">ftp://niteroi.gsfc.nasa.gov/pub/uwm_coads/1x1/data/clm/README</a>

Jones/Parker	Jones Parker Merged Surface Air Temperature IPCC data set
Name in Data Files:	jones
Time Type:	time series
Frequency	mo
Time Period:	185701-199901
Quality Rating	B
Comment:	Observed sfc air temperature for IPCC; 5 deg grid
Citation:	Parker et al. 1994
Reference(s);	Parker, D.E., Jones, P.D., Bevan, A. and Folland C.K., 1994: Interdecadal changes of surface temperature since the late 19th century. <i>J. Geo. Res.</i> , <b>99</b> , 14373-14399.1
Web Resource	<a href="http://www.cru.uea.ac.uk/cru/data/temperat.htm">http://www.cru.uea.ac.uk/cru/data/temperat.htm</a>

# PCMDI Performance Portrait diagrams

The performance portrait diagrams provide statistical information about model output relative to a reference (usually observational) data set in a tabular form, but with the numerical values of the table replaced by shades of red and blue colors. The principal use of these diagrams is to readily identify significant changes in large numbers of variables across multiple models. Typically, the colors indicate the relative size of the root-mean-square (RMS) errors. Smaller errors are represented by blue colors, whereas larger errors are represented by red colors. Darker hues indicate the more extreme ends of the range of values.

For this study, numerous climate variables are analyzed by these performance portraits over a selection of seasons and geographical ranges. Temporal averaging is performed first followed by application of the formulae defined below. Four different latitude bands over all longitudes are considered. They are global, 90N-20N, 20N-20S and 20S-90N. Together these two dimensions define the *components* of the variables.

## Definition of the normalized root-mean-square (RMS) error.

Depending on the variable considered and the units of measure adopted the magnitudes of the root-mean-square (RMS) errors can differ widely. In order to express the errors in non-dimensional form, which facilitates comparisons across different fields, the errors are normalized by the standard deviation of the observed field. The normalized root-mean-square error,  $E$ , for model-simulated field,  $f$ , compared with observed field,  $r$ , is defined as follows:

$$E = \frac{1}{\sigma_r} \left[ \frac{1}{N} \sum_{n=1}^N (f_n - r_n)^2 \right]^{1/2} \quad (1)$$

where the sum includes all points (covering all dimensions of interest—space and/or time) and  $\sigma_r$  is the standard deviation of the observed field. When the sum includes the longitude and/or latitude dimension, the elements are weighted by grid-cell area (i.e., area weighted). In this study, both the model and observed data are mapped to a  $2.5^\circ \times 2.5^\circ$  latitude-longitude grid defined by the ECMWF reanalysis before computing the statistics.

## Definitions of the normalized "bias" and normalized "centered RMS difference".

The total (or uncentered) RMS error, defined by (1), can be resolved into two components in order to isolate the differences in the centered patterns from differences in the means of the two fields. The overall magnitude of the normalized "bias" is defined as the absolute value of the overall mean difference between the two fields divided by the standard deviation of the observed field:

$$\bar{E} = |\bar{f} - \bar{r}| / \sigma_r, \quad (2)$$

where the overbar indicates an average over all points (again covering all dimensions of interest—space and/or time). Figure 1a shows a typical representation of the normalized bias error of a single model. In this figure, all variables and components considered are shown. Because this figure shows the actual values of the normalized bias error, there is a wide range of values indicated by the color bar. In figure 1b, the same information is shown except that all models under consideration are percentile ranked against each other. The model with the smallest error is ranked highest (100<sup>th</sup> percentile, indicated by darkest blue), while the model with the largest error is ranked lowest (0<sup>th</sup> percentile, indicated by deepest red). The rank of the other models is indicated by lighter shades of red (below the 50<sup>th</sup> percentile) and blue (above the 50<sup>th</sup> percentile).

The normalized centered RMS or pattern difference is defined as the RMS difference computed after the overall bias has been removed from each field:

$$E' = \frac{1}{\sigma_r} \left\{ \frac{1}{N} \sum_{n=1}^N [(f_n - \bar{f}) - (r_n - \bar{r})]^2 \right\}^{1/2}. \quad (3)$$

Figure 2 shows a typical normalized pattern error of a single model. Interpretation of the axes and color ranges is the same as for figure 1a.

The two components add quadratically to yield the total normalized mean-square error:

$$E^2 = \bar{E}^2 + E'^2. \quad (4)$$

Figure 3 shows a typical normalized total error of a single component of all variables for all models. Interpretation of the axes and color ranges again is the same as for figure 1a. Figure 4 shows a typical portrait of the total normalized error of a single variable. In this case, all models and components are shown. Similar plots showing the portrait of a single component can also be made. These are particularly useful in portraying variability behavior of a model. However, in the first phase of this study we have not used them as the forcing function is climatologically averaged.

#### **Comparison of errors (i.e., error differences).**

It is also possible to show changes from one model version to another in the normalized RMS error, equation (1), relative to the reference data set. These changes can be expressed as absolute differences or as fractional changes in the error (expressed as a percent). Consider, for example, the normalized difference in the centered RMS error, equation (3), between the original version of a model (model 0) and a revised version (model 1). The difference in RMS errors is given by:

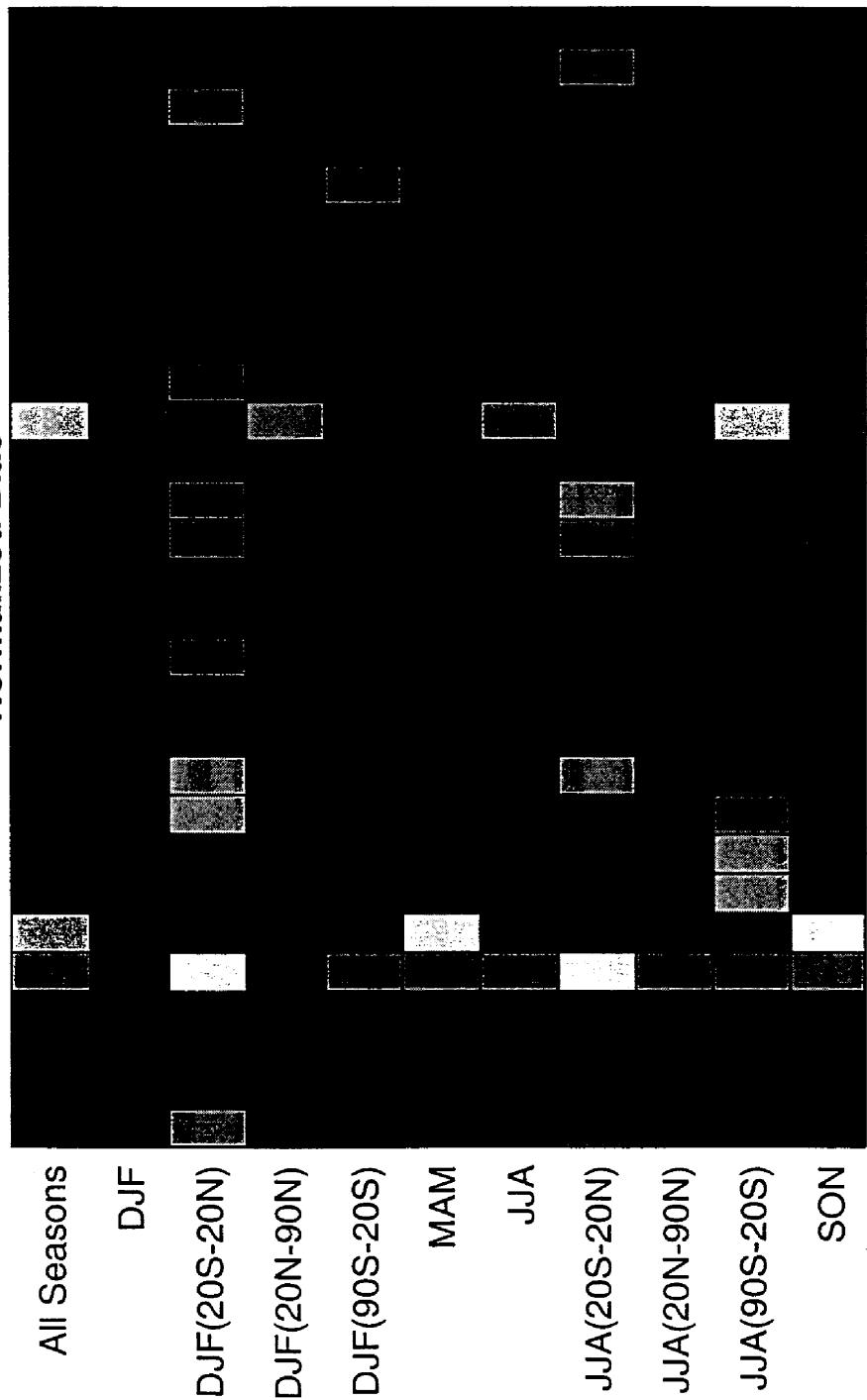
$$\Delta E' = E'_1 - E'_0 \quad (5)$$

The fractional change in pattern error is expressed as a percent. For the total (uncentered) RMS error, for example, the fractional change in the error is given by:

$$\delta E = 100 \frac{E_1 - E_0}{(E_0 + E_1)/2} \quad (6)$$

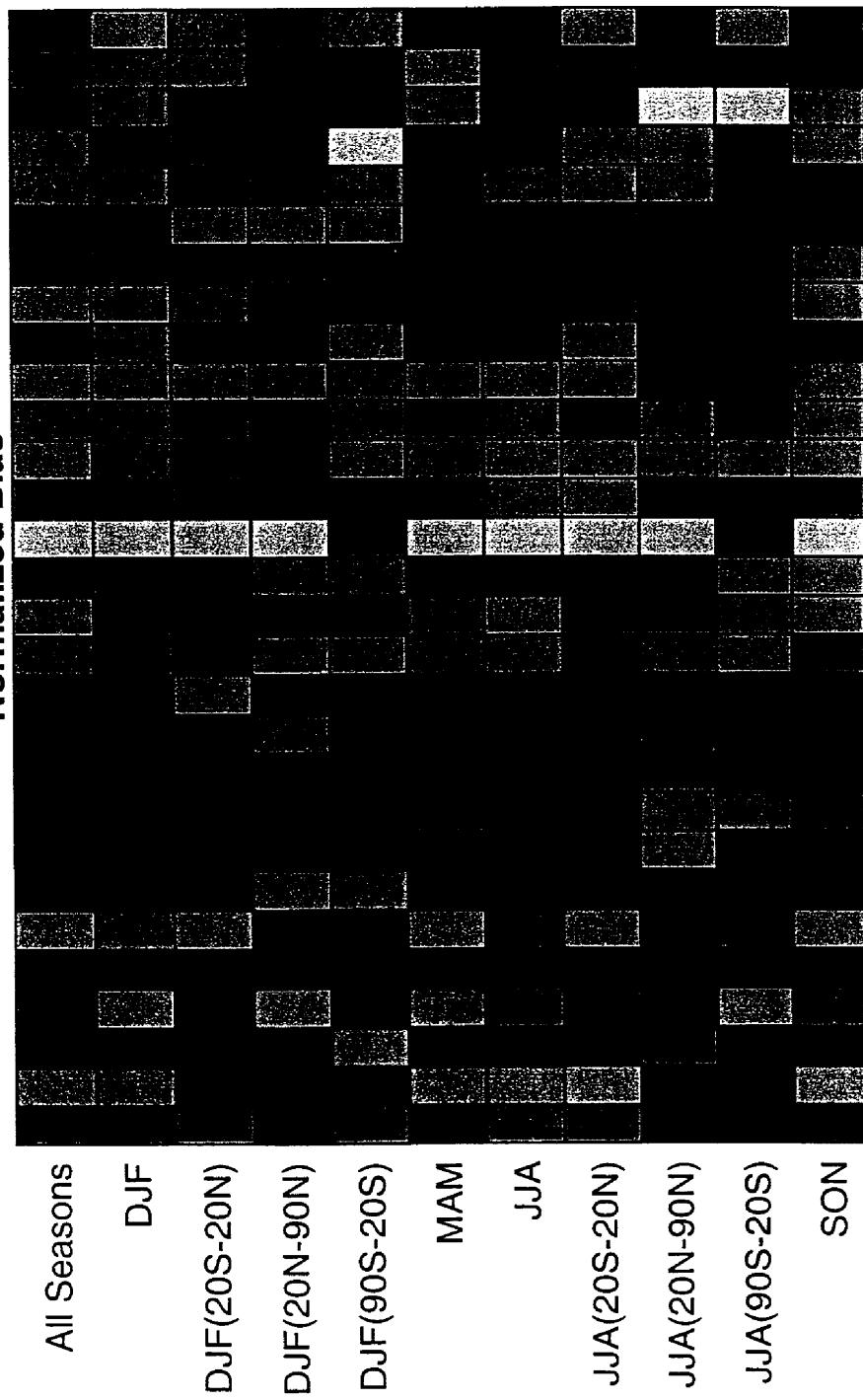
Figure 5 shows the changes in total normalized error in one model's performance relative to another model's for all components of all variables. Variables that show improvement are indicated by blue. Those that got worse are indicated in red. Darker hues represent larger changes than do lighter hues. Figure 6 shows the same the change in total normalized error in one component of all variables for all models.

## CCM3.9.11 AMIP2 Normalized Bias



**Figure 1a**

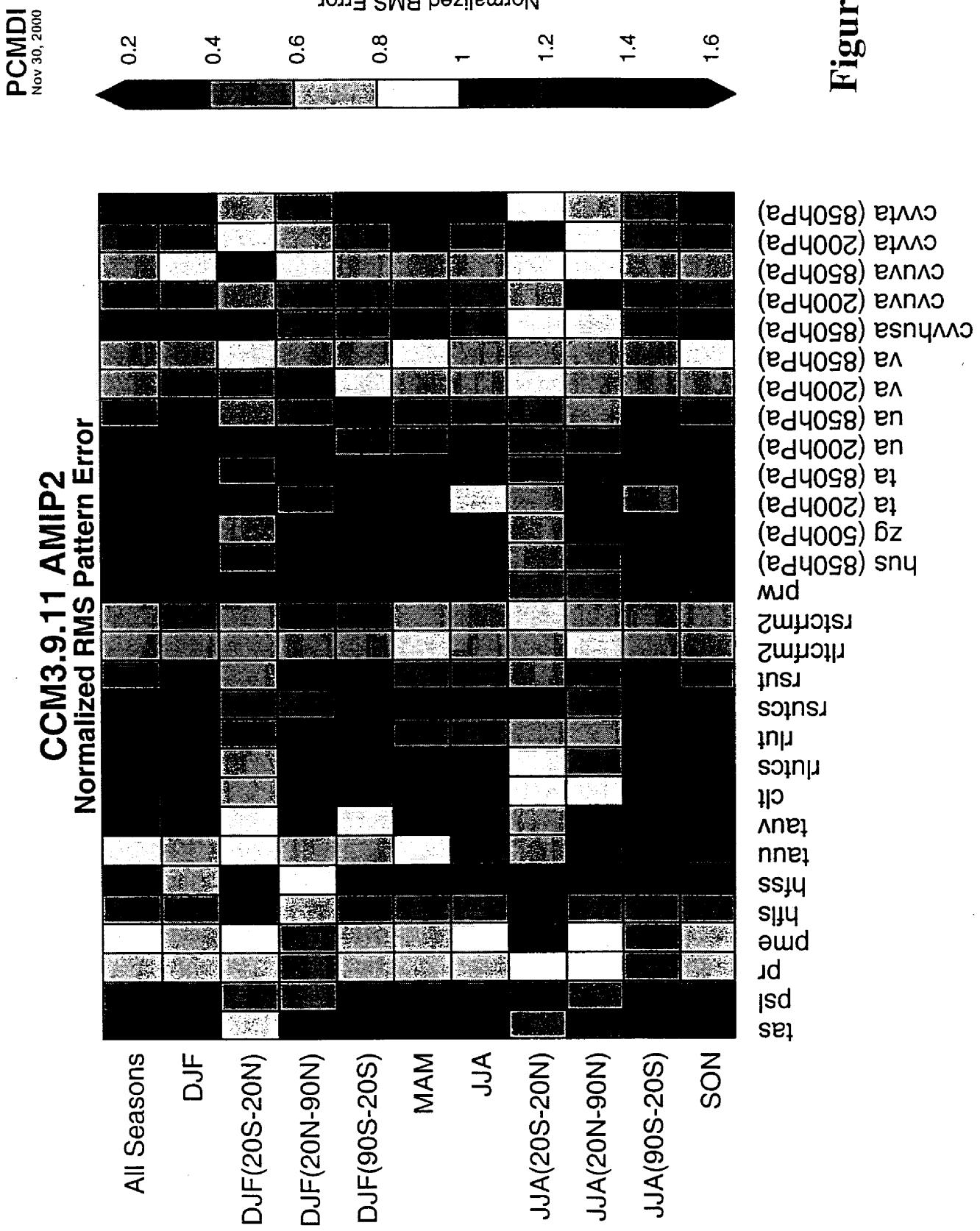
## CCM3.9.11 AMIP2 Normalized Bias



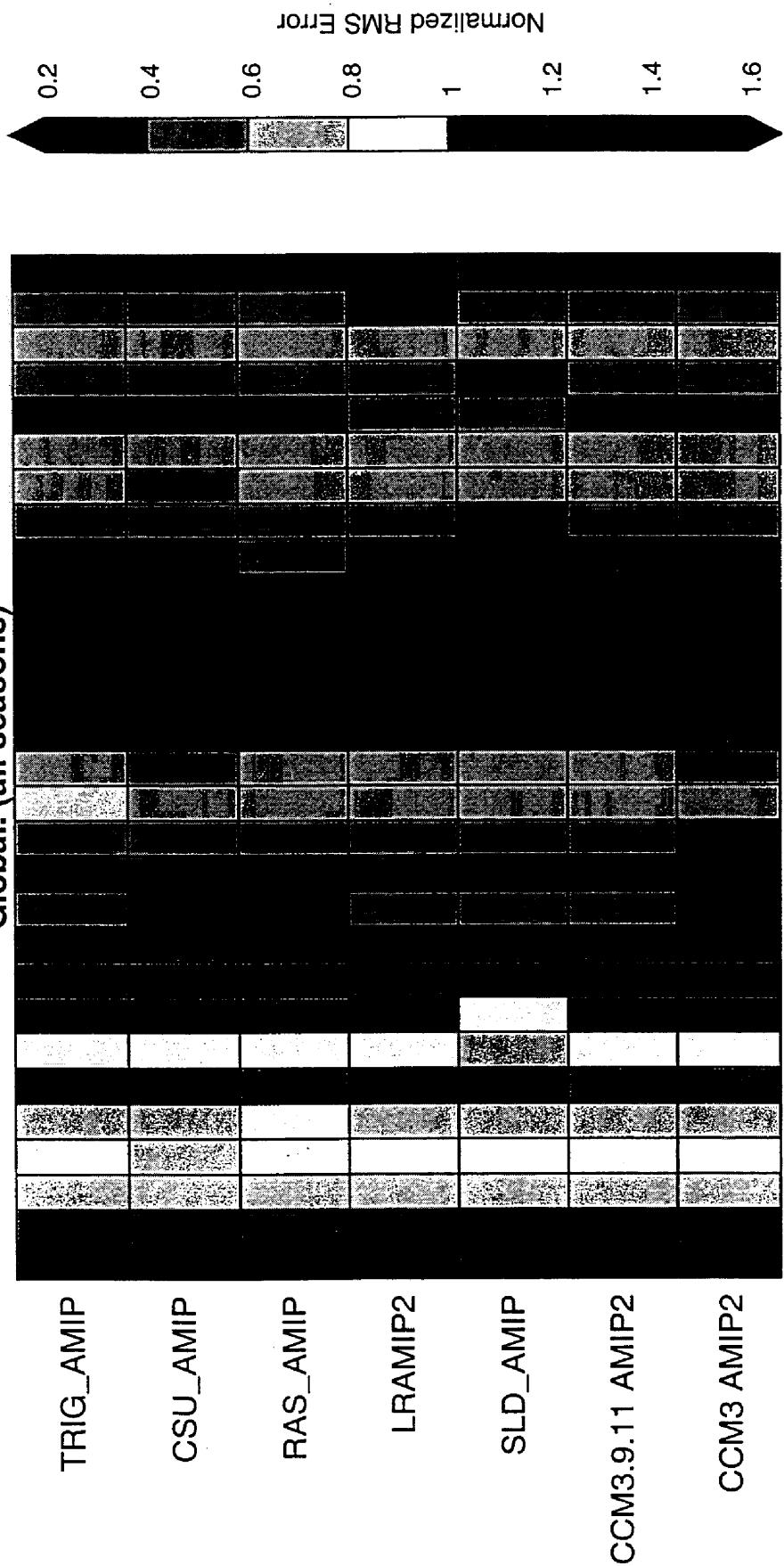
tas  
pr  
hfls  
hfs  
tauu  
tauv  
clt  
rlt�cs  
rsut  
rltcrf2  
prw  
hns (850hPa)  
ta (850hPa)  
ua (850hPa)  
ua (200hPa)  
va (850hPa)  
va (200hPa)  
cvhusa (850hPa)  
cvhusa (200hPa)  
cvuva (850hPa)  
cvuva (200hPa)  
cvwta (850hPa)  
cvwta (200hPa)

**Figure 1b**

**Figure 2**



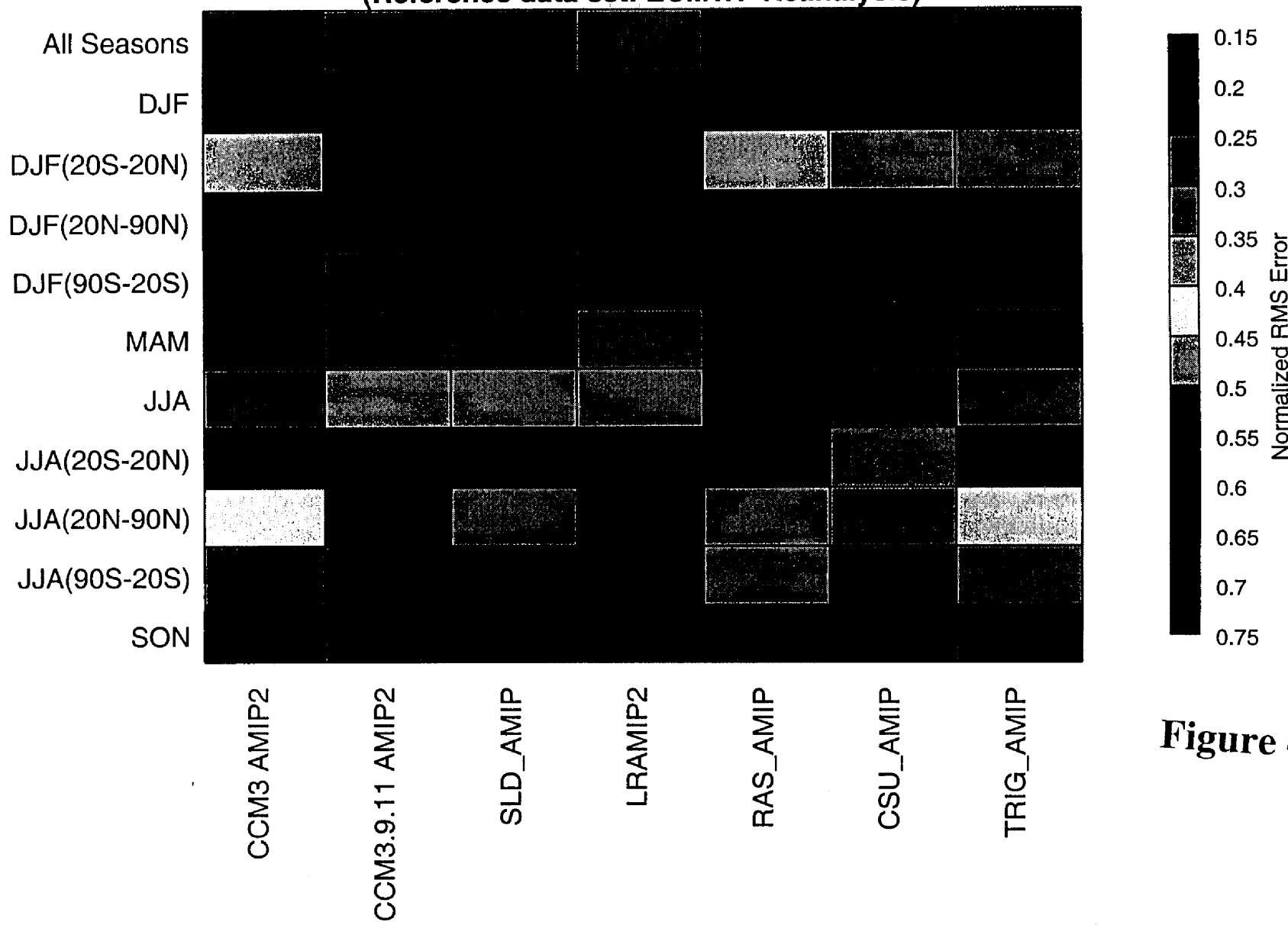
### Normalized Total Error. Global. (all seasons)



**Figure 3**

tas  
 prsl  
 hfls  
 hfs  
 hfls  
 hfs  
 rltics  
 rsut  
 ta  
 zg  
 ua  
 va  
 cvhua  
 cvvua  
 cvvta  
 cvvta

**prw: Normalized Total Error**  
(Reference data set: ECMWF Reanalysis)



**Figure 4**

## AMIP30L: Percentage Difference from CCM3 AMIP2 Normalized Total Error

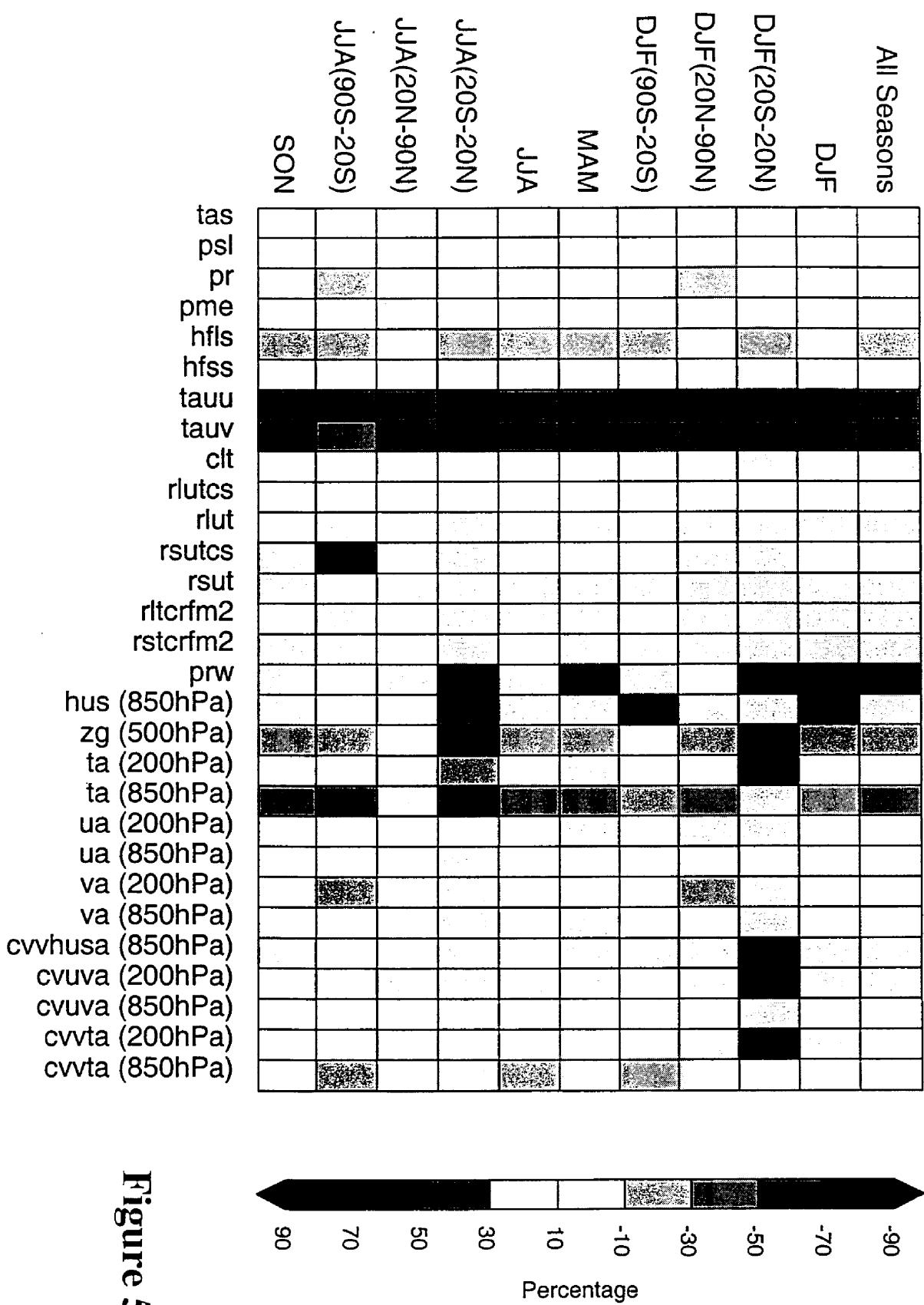
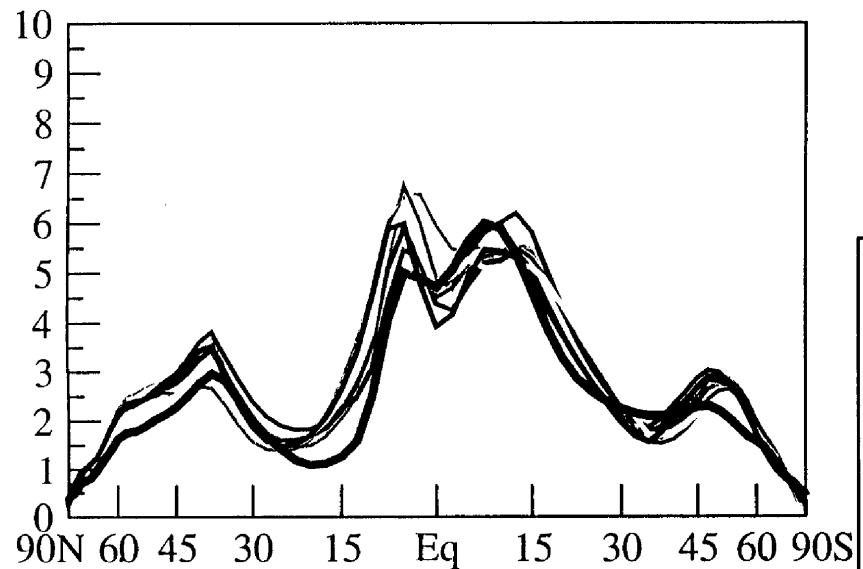


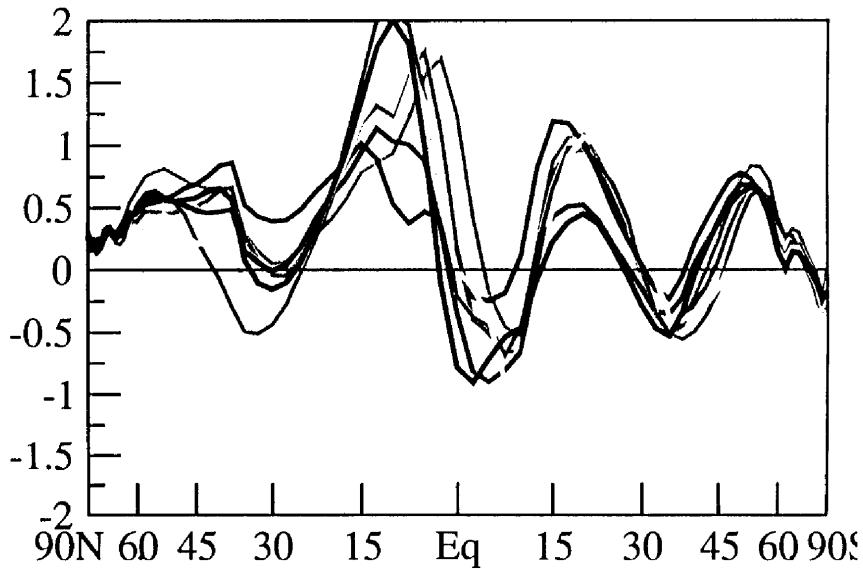
Figure 5

# Total precipitation rate

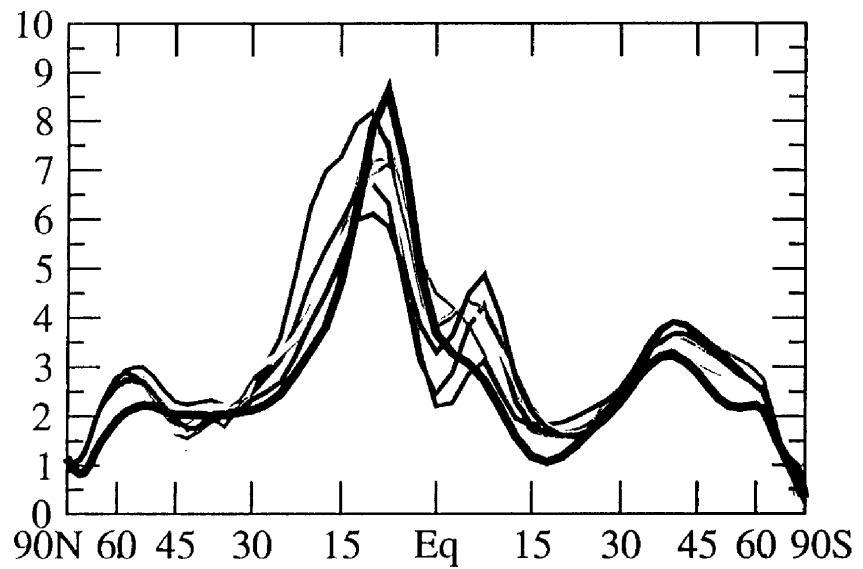
DJF Climatology



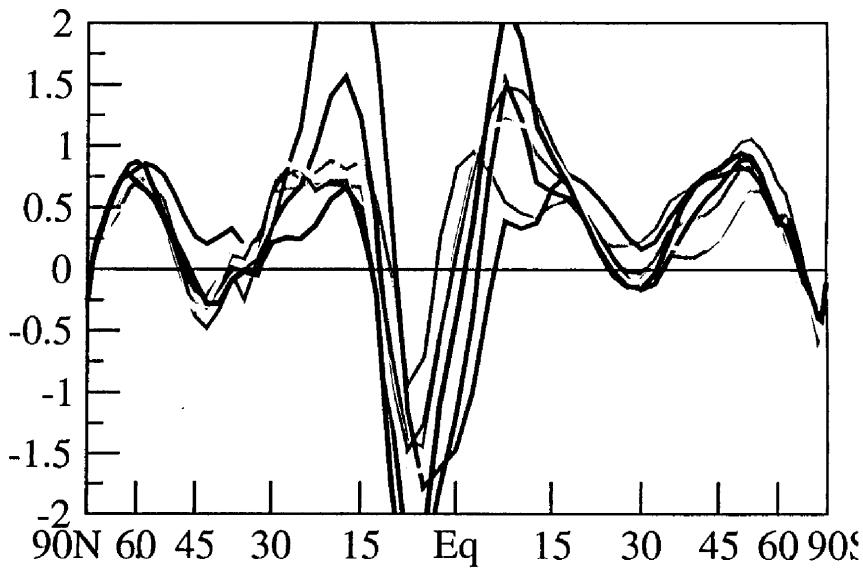
DJF Models minus Reference



JJA Climatology

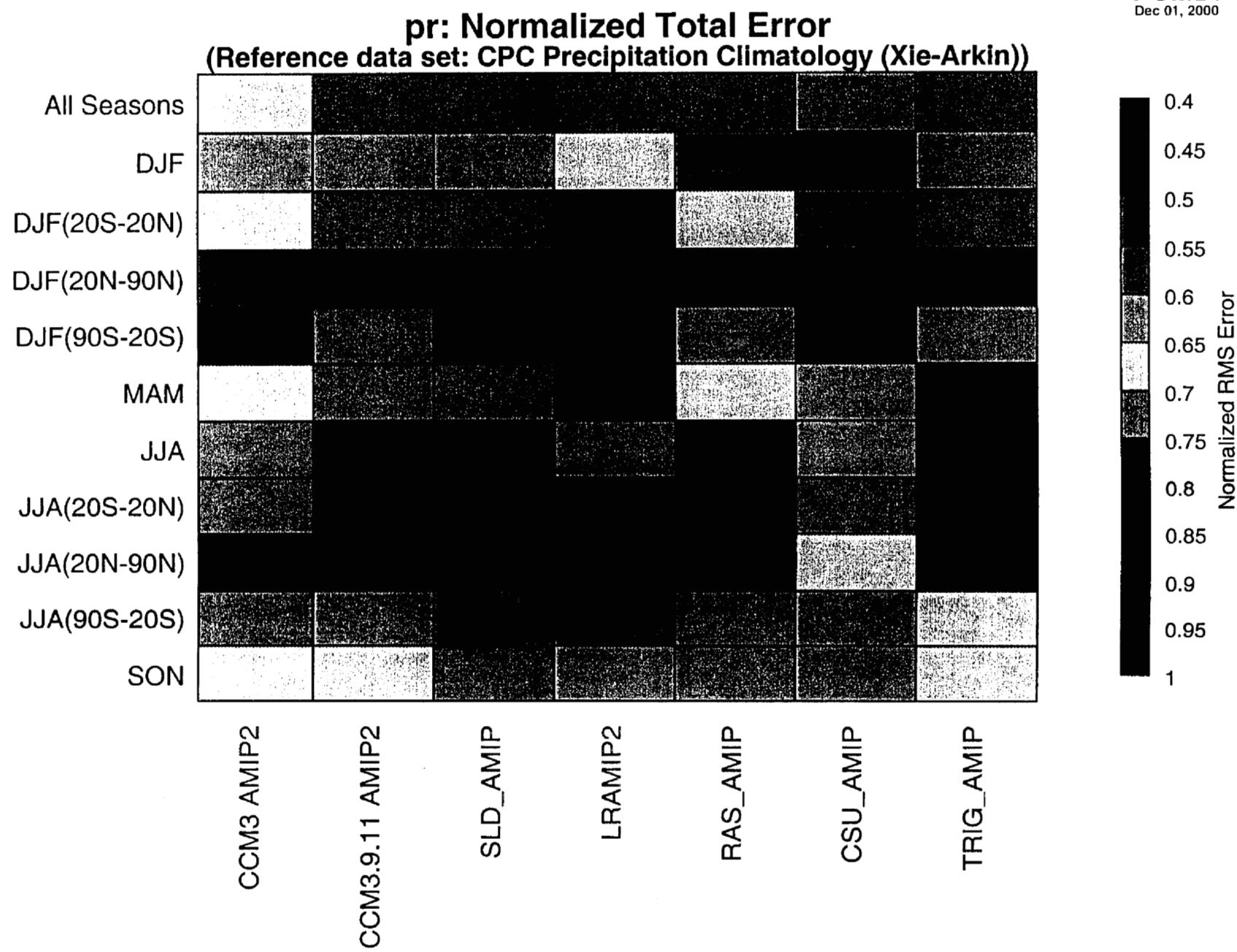


JJA Models minus Reference



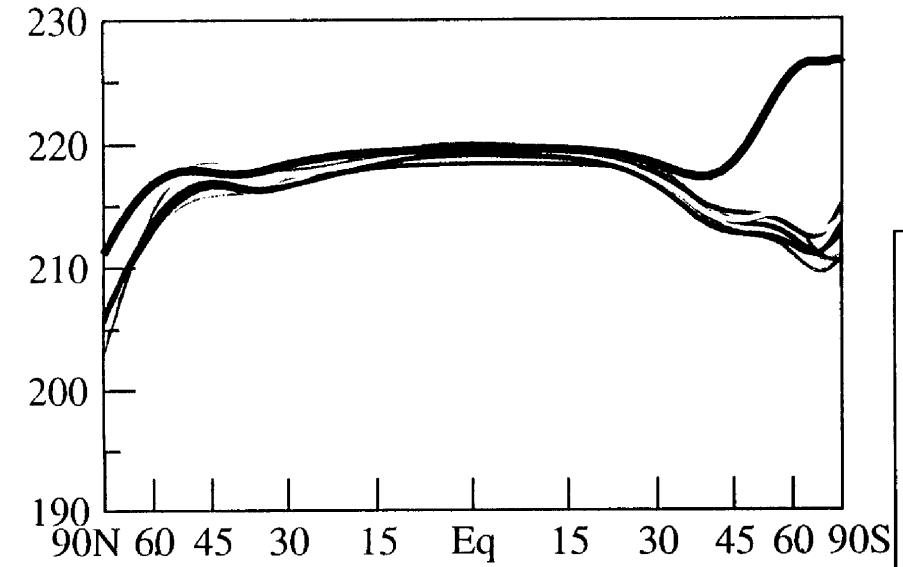
Latitude

Latitude

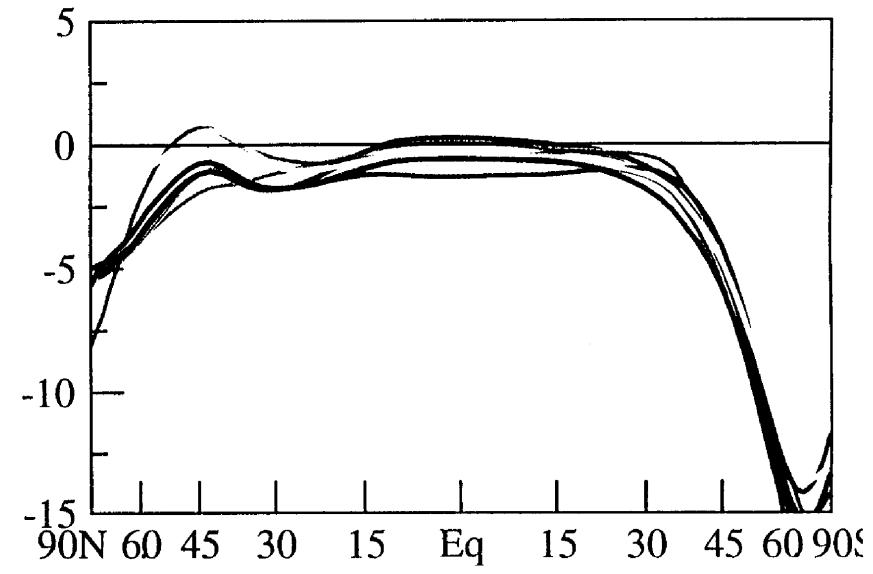


# 200mb Air Temperature

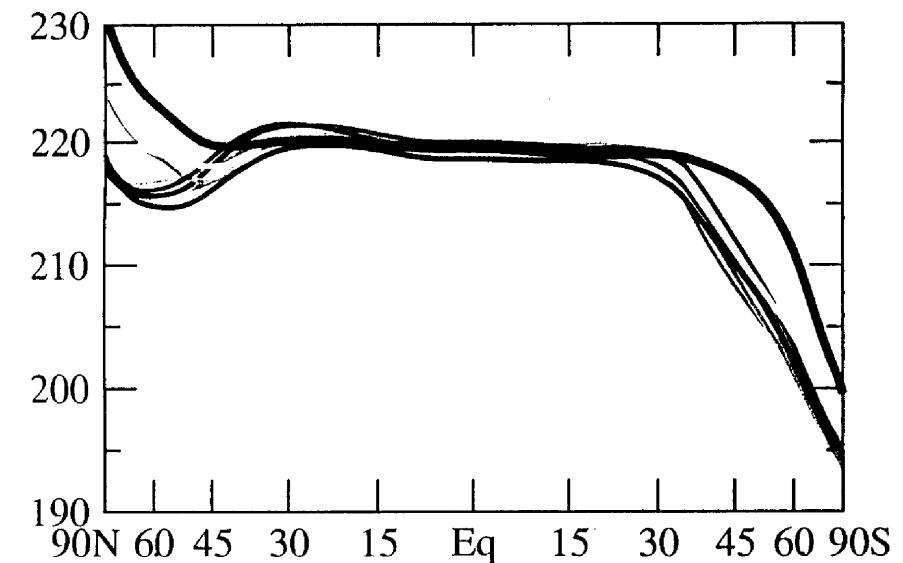
DJF Climatology



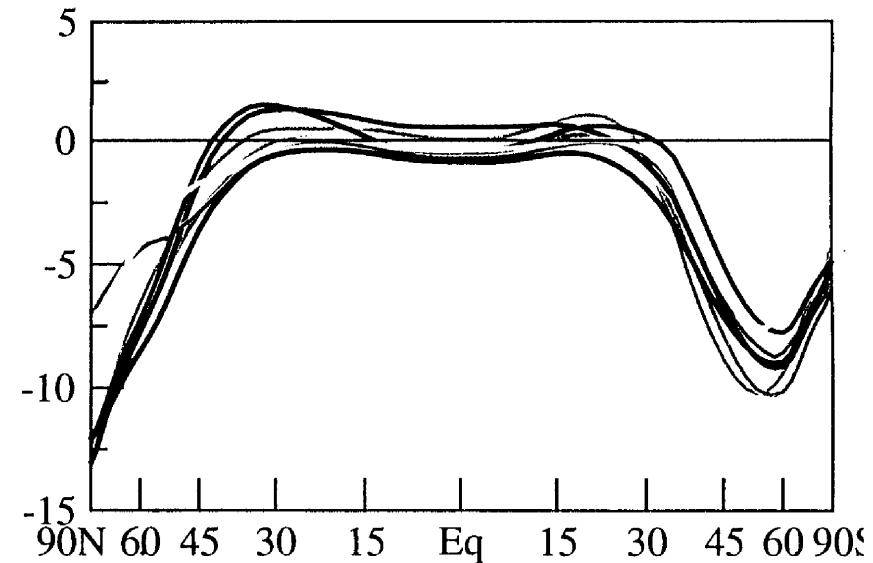
DJF Models minus Reference



JJA Climatology



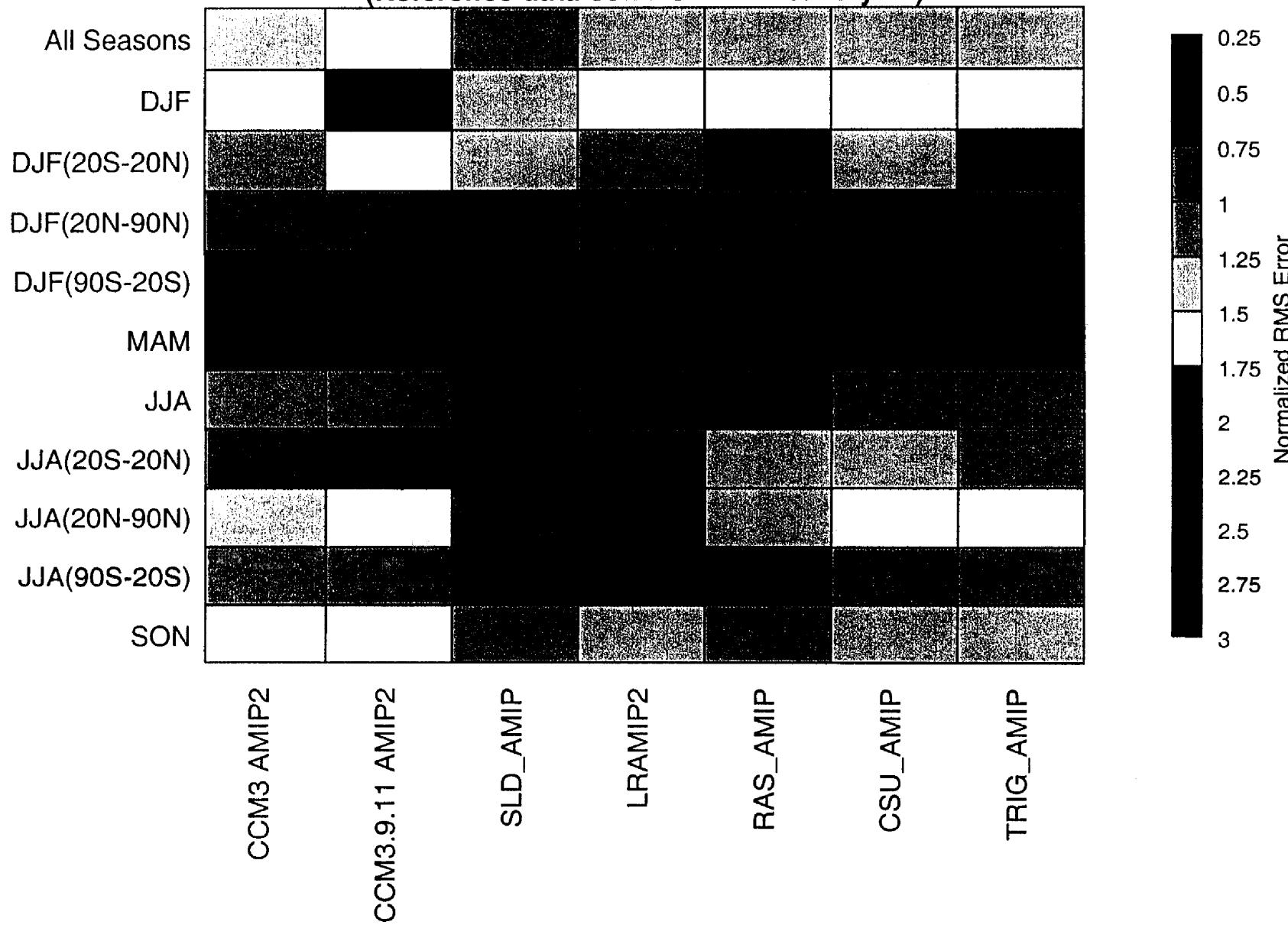
JJA Models minus Reference



Latitude

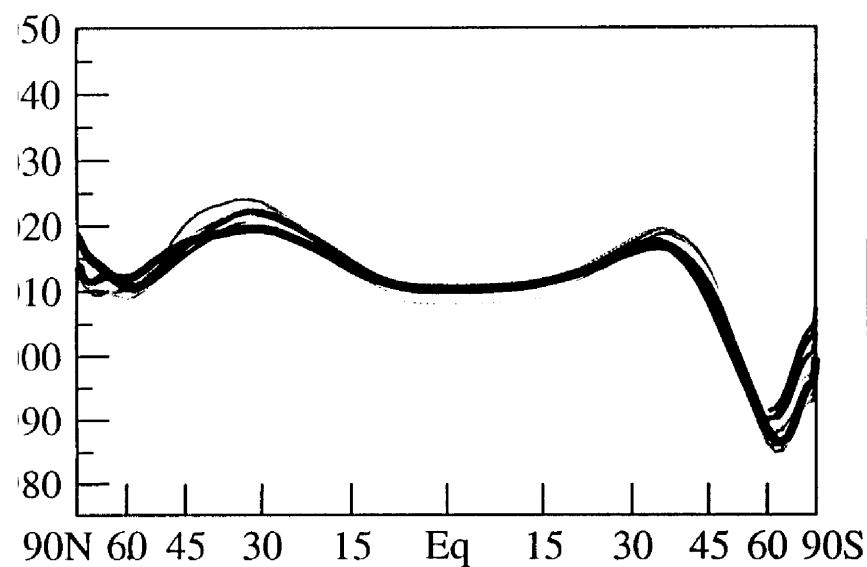
Latitude

# **ta200: Normalized Total Error (Reference data set: ECMWF Reanalysis)**

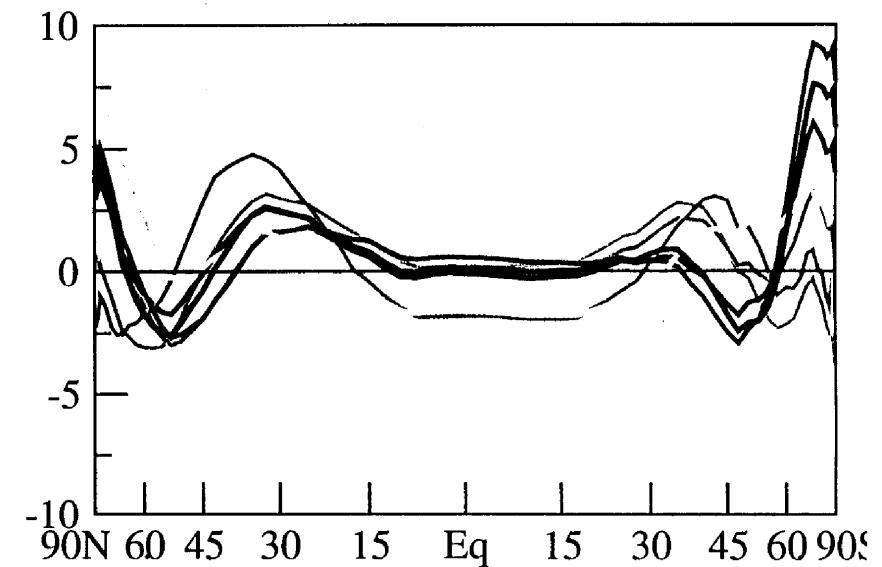


# Sea Level Pressure

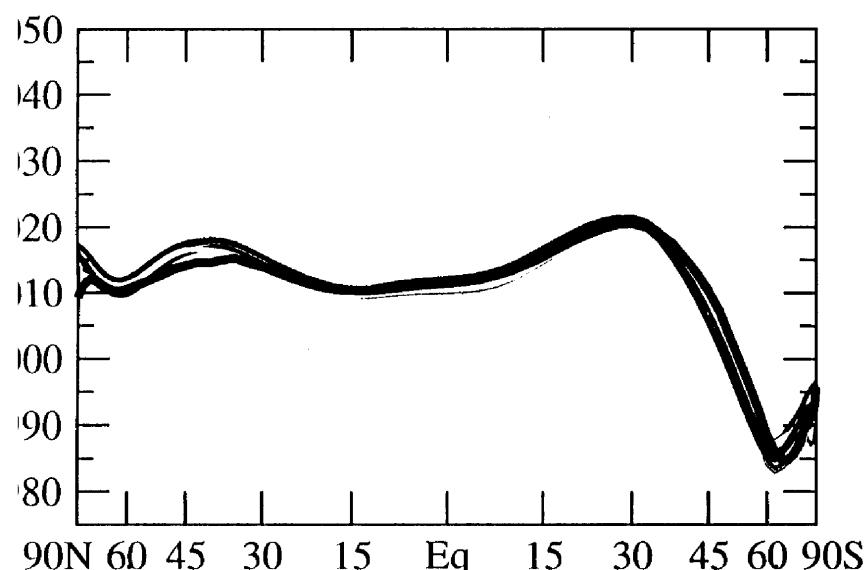
DJF Climatology



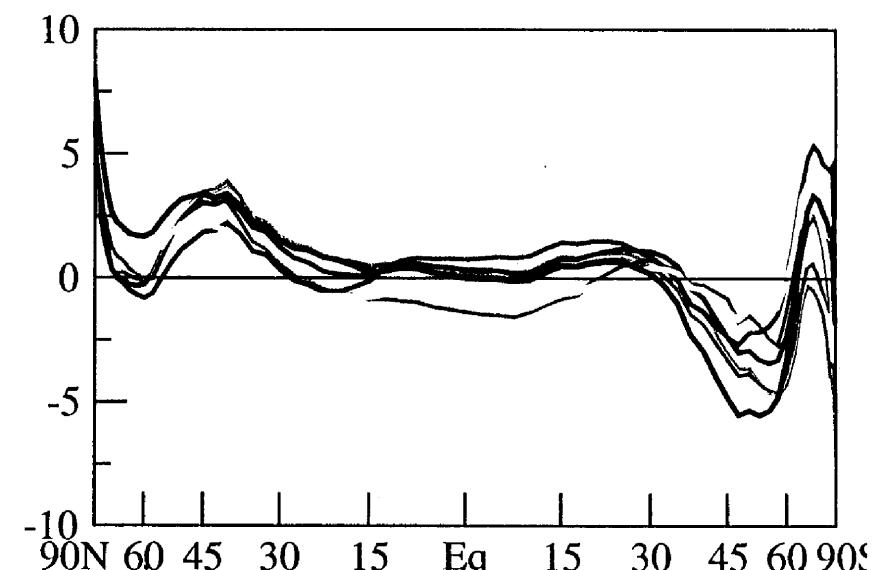
DJF Models minus Reference



JJA Climatology



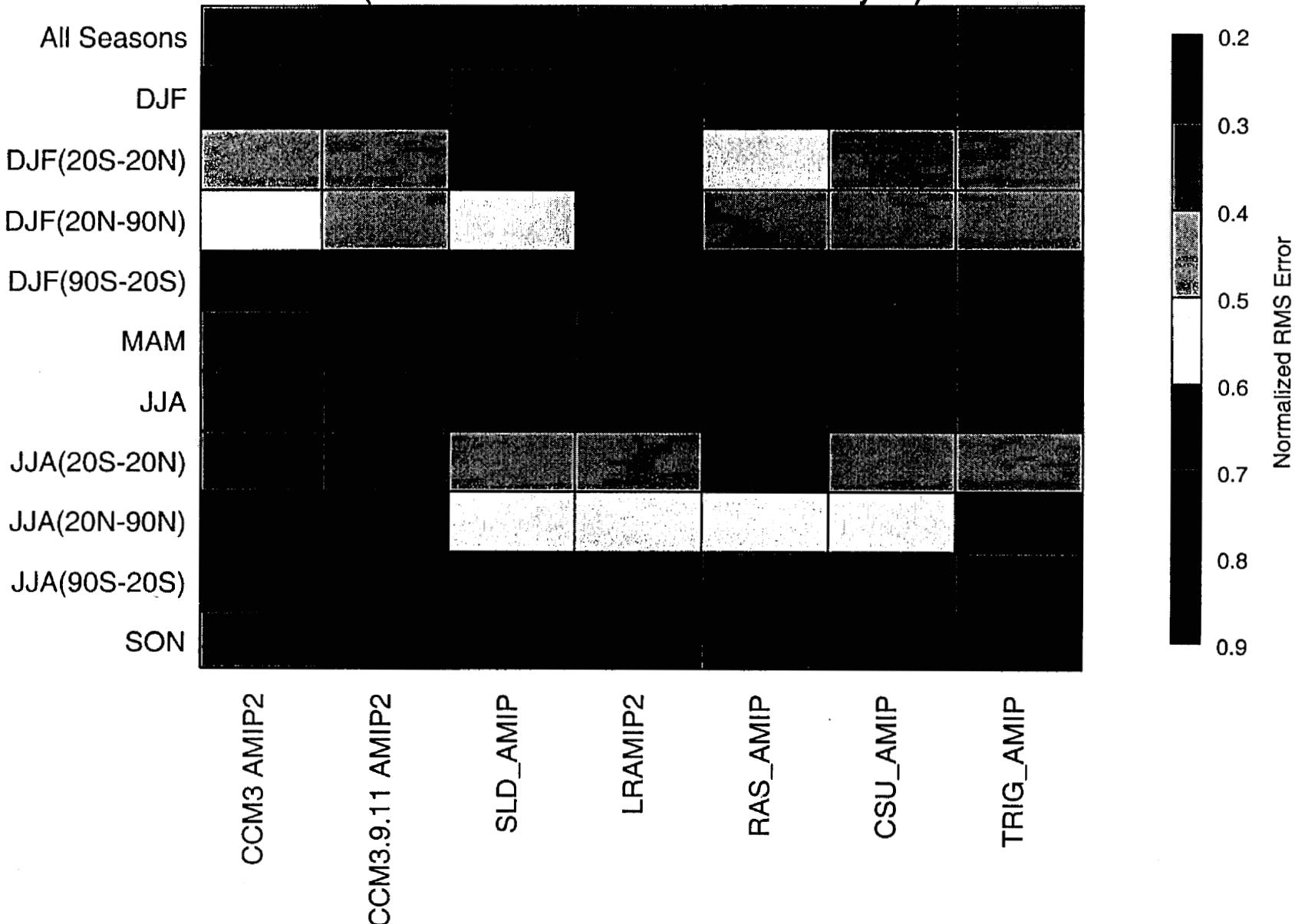
JJA Models minus Reference



Latitude

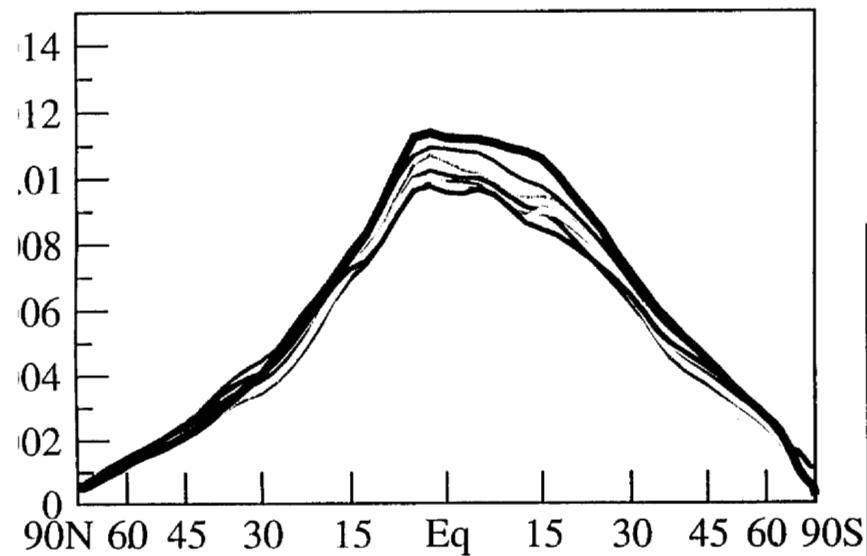
Latitude

**psl: Normalized Total Error**  
(Reference data set: ECMWF Reanalysis)

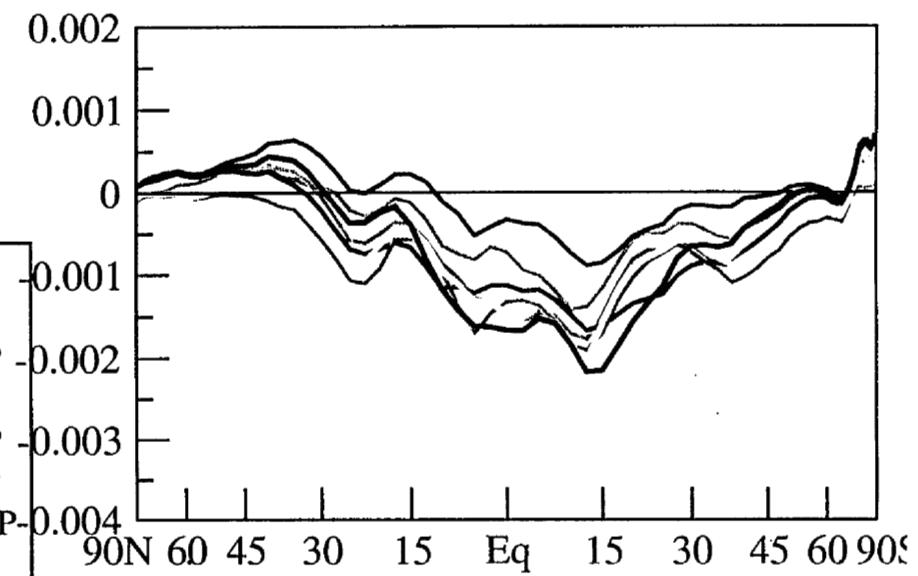


# Specific humidity at 850mb

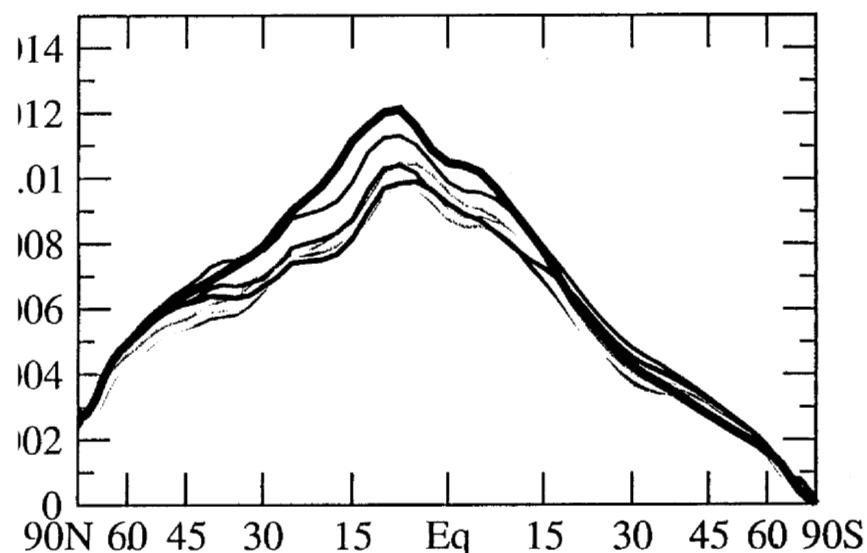
DJF Climatology



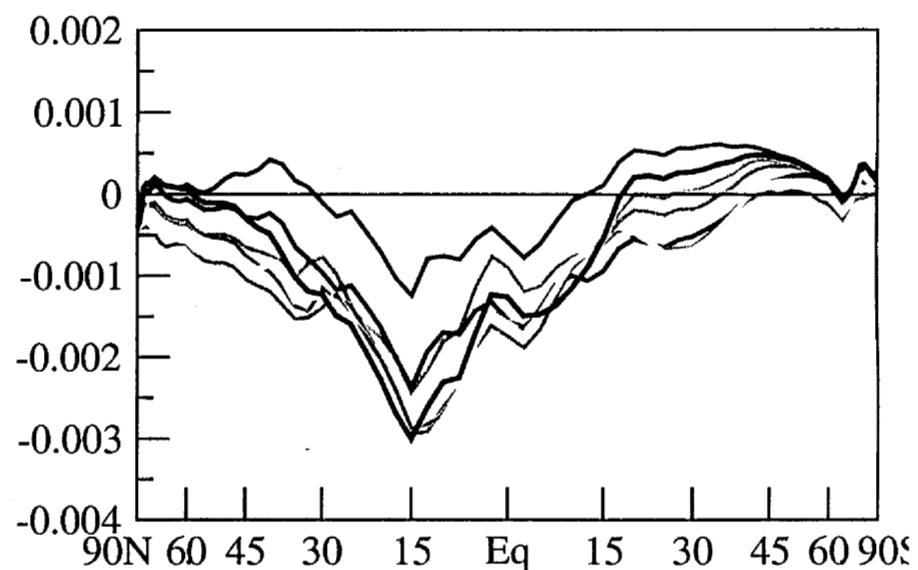
DJF Models minus Reference



JJA Climatology



JJA Models minus Reference



Latitude

Latitude

**hus850: Normalized Total Error  
(Reference data set: ECMWF Reanalysis)**

PCMDI  
Dec 02, 2000

All Seasons

DJF

DJF(20S-20N)

DJF(20N-90N)

DJF(90S-20S)

MAM

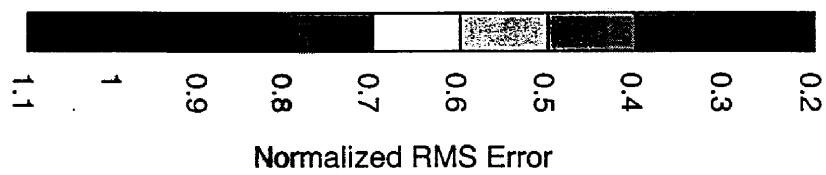
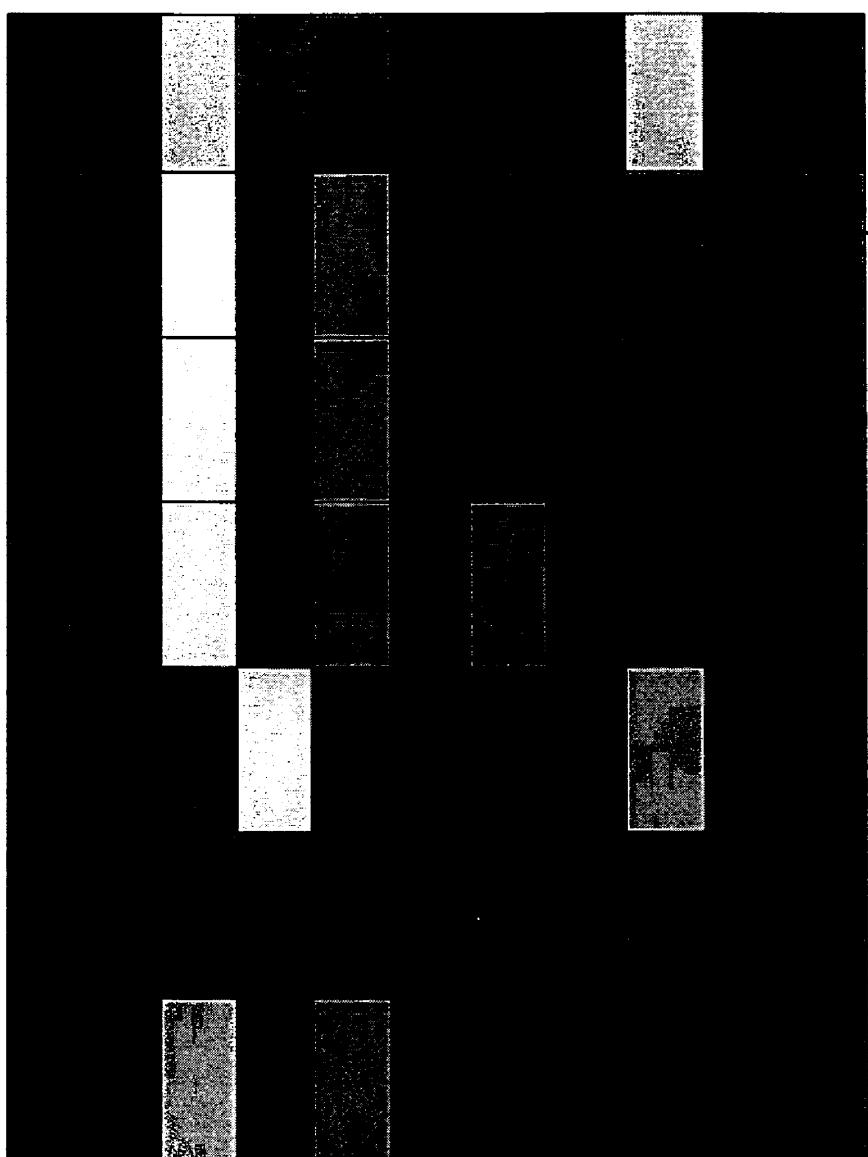
JJA

JJA(20S-20N)

JJA(20N-90N)

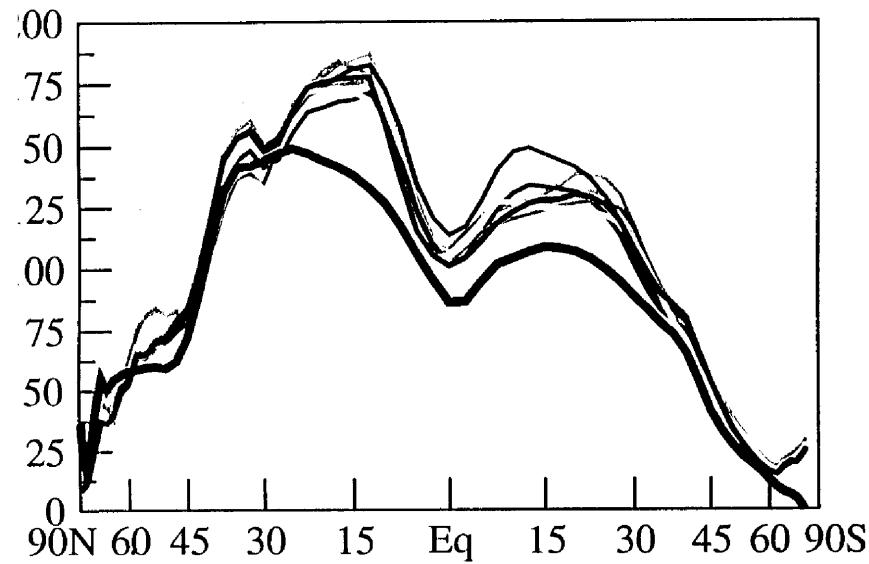
JJA(90S-20S)

SON

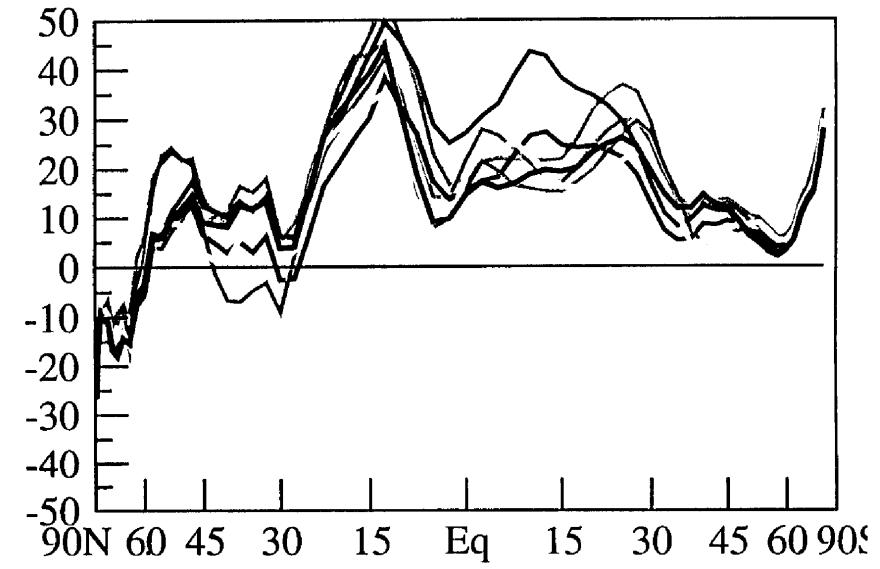


# Heat flux latent surface

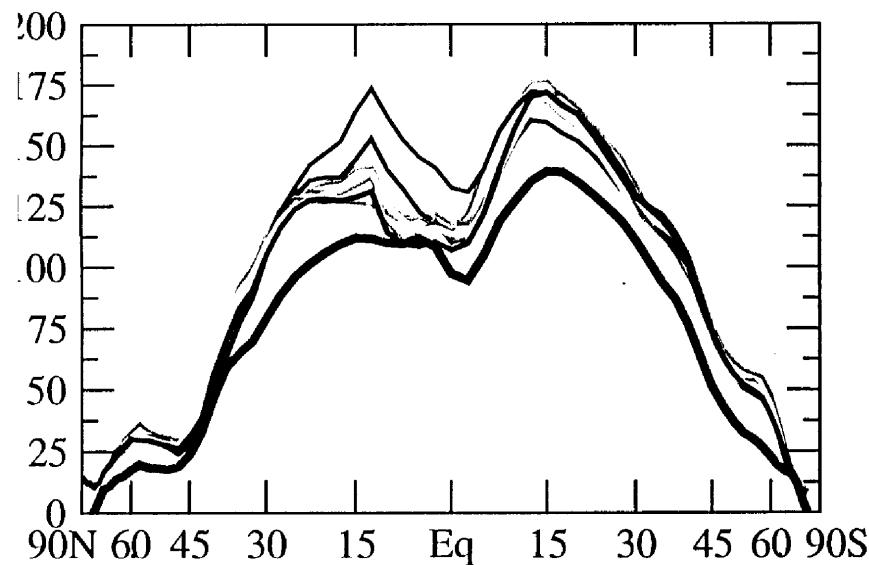
DJF Climatology



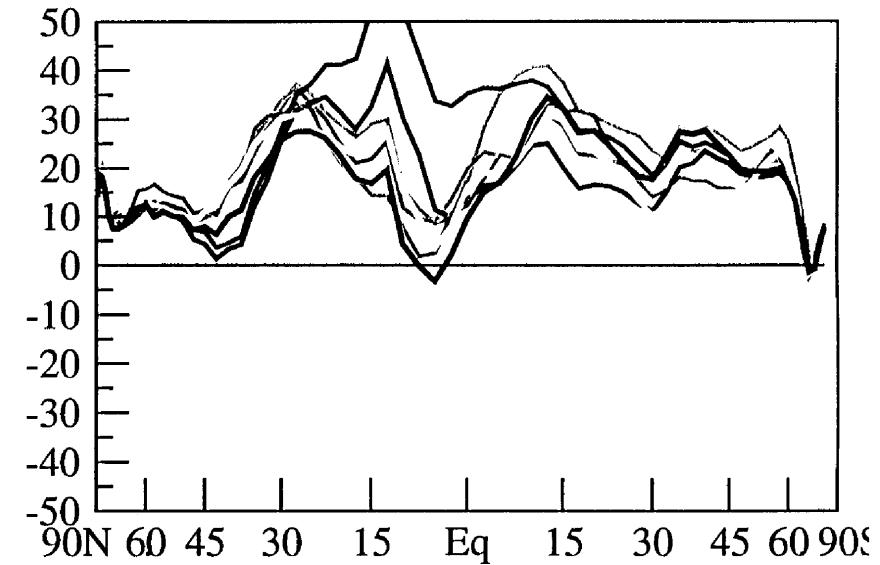
DJF Models minus Reference



JJA Climatology



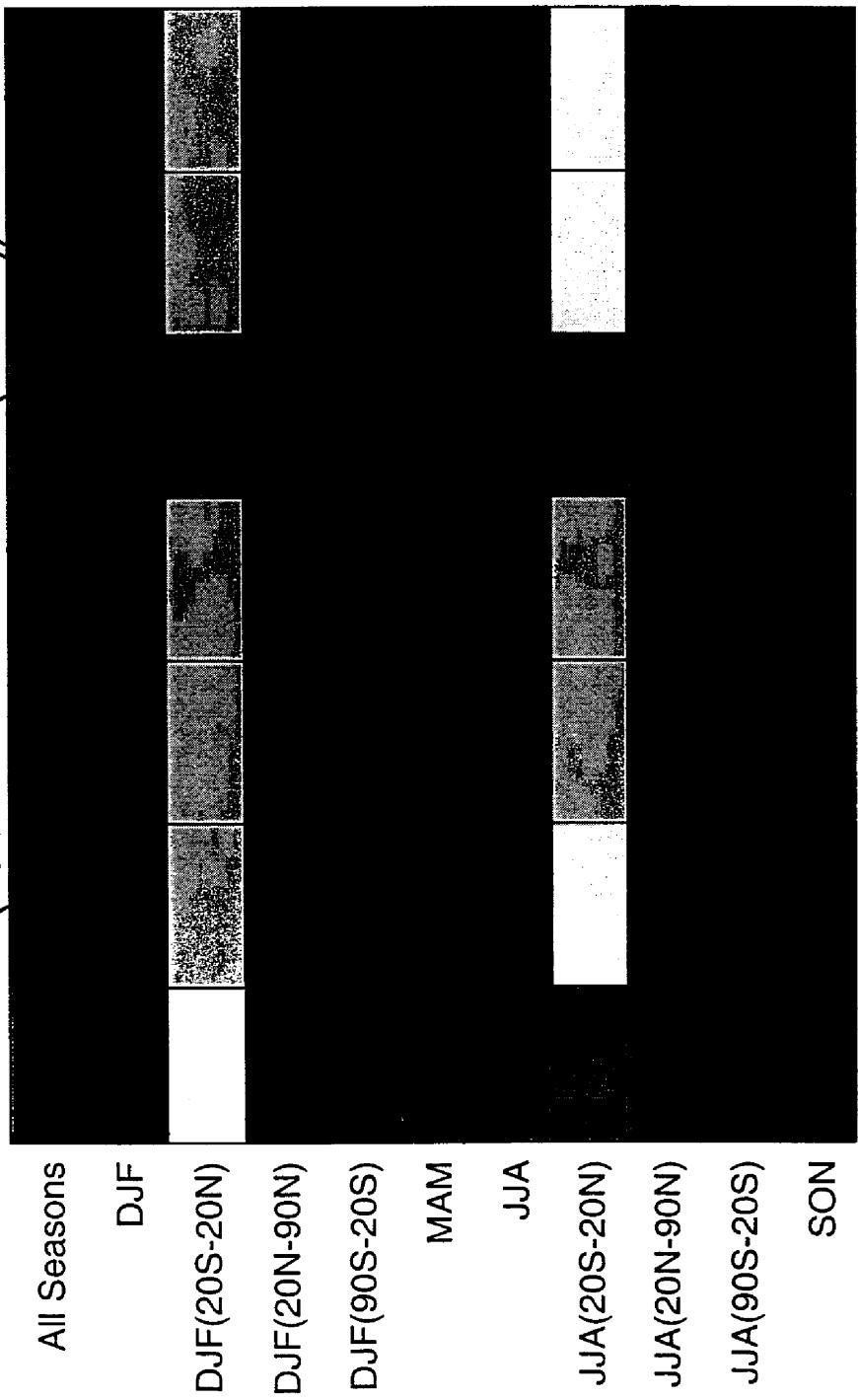
JJA Models minus Reference



Latitude

Latitude

**hf1s: Normalized Total Error**  
(Reference data set: COADS (DaSilva))



TRIG\_AMIP

CSU\_AMIP

RAS\_AMIP

LRA\_MIP2

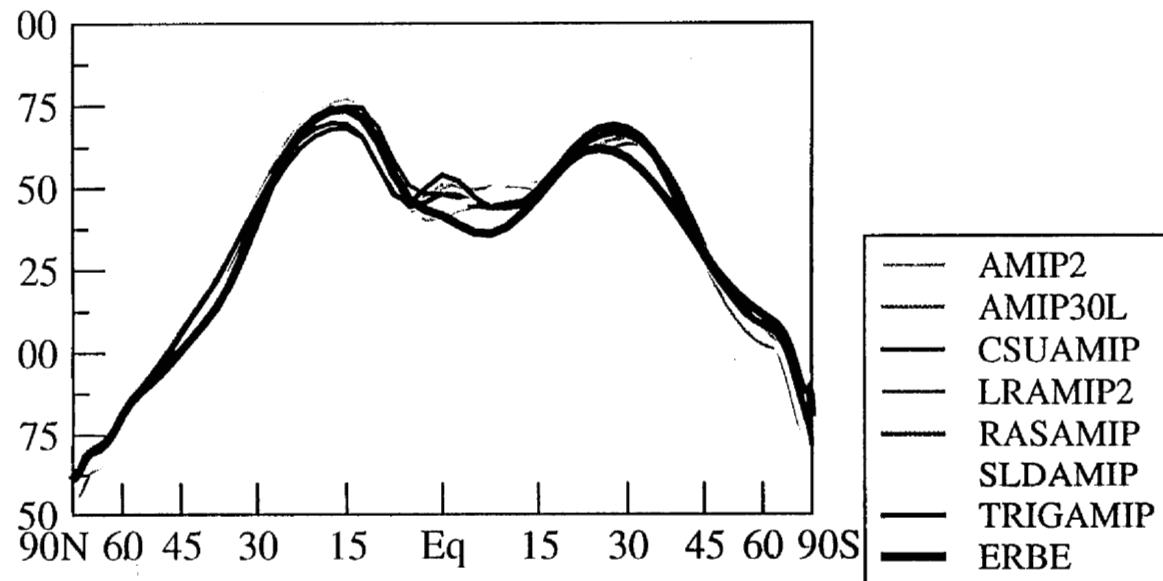
SLD\_AMIP

CM3.9.11\_MIP2

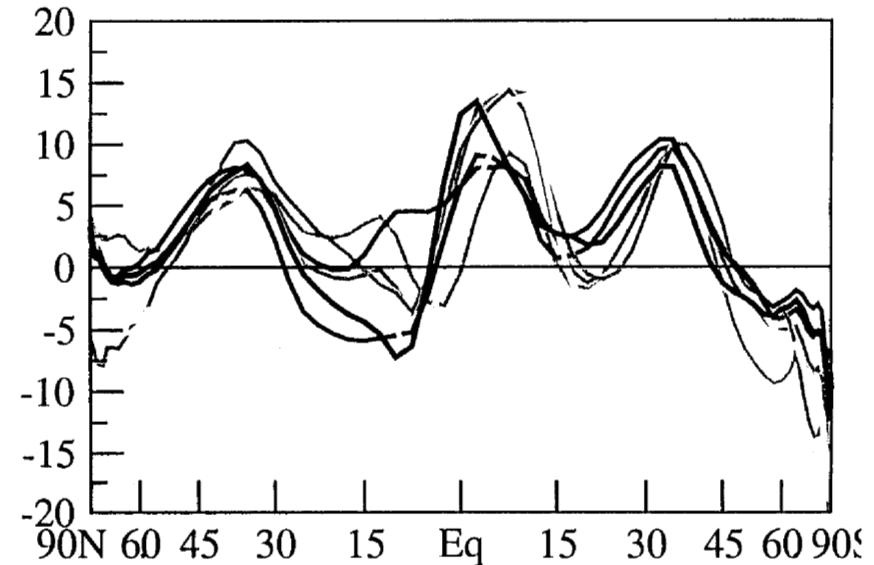
CM3\_MIP2

# LW radiation TOA (OLR)

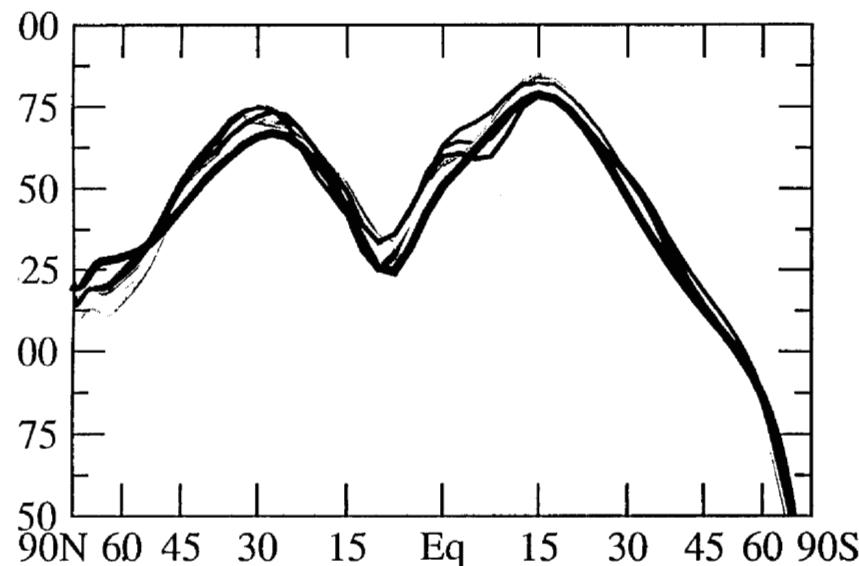
DJF Climatology



DJF Models minus Reference

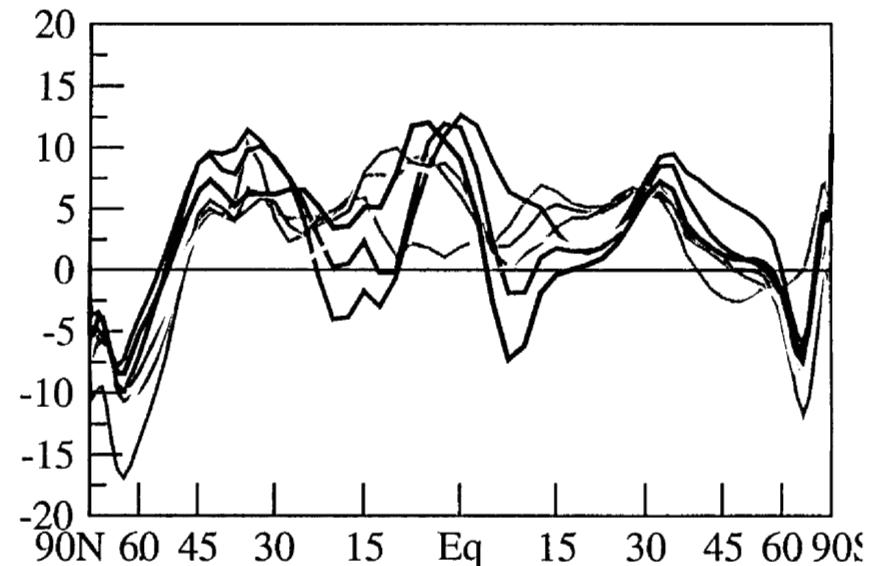


JJA Climatology



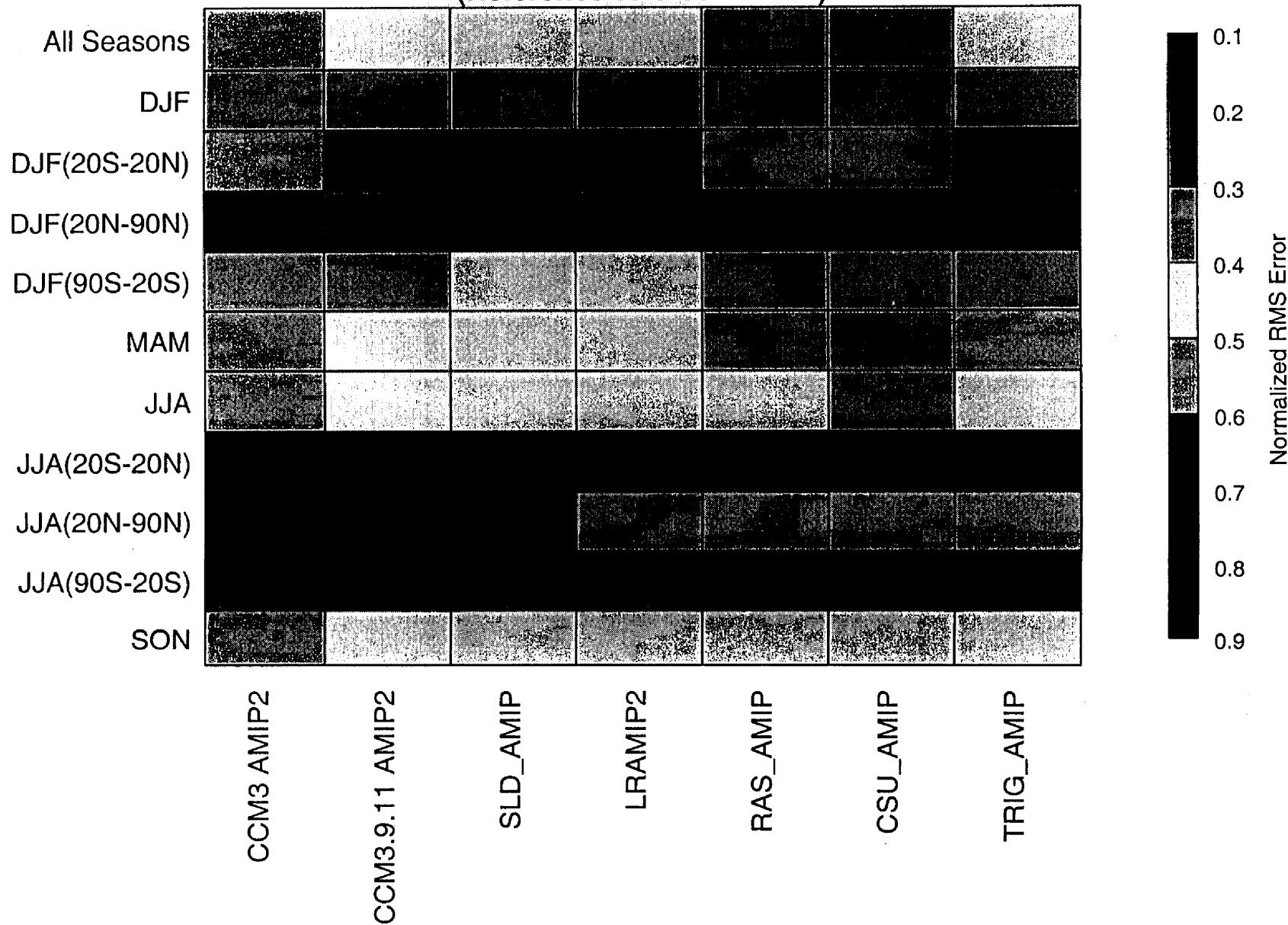
Latitude

JJA Models minus Reference



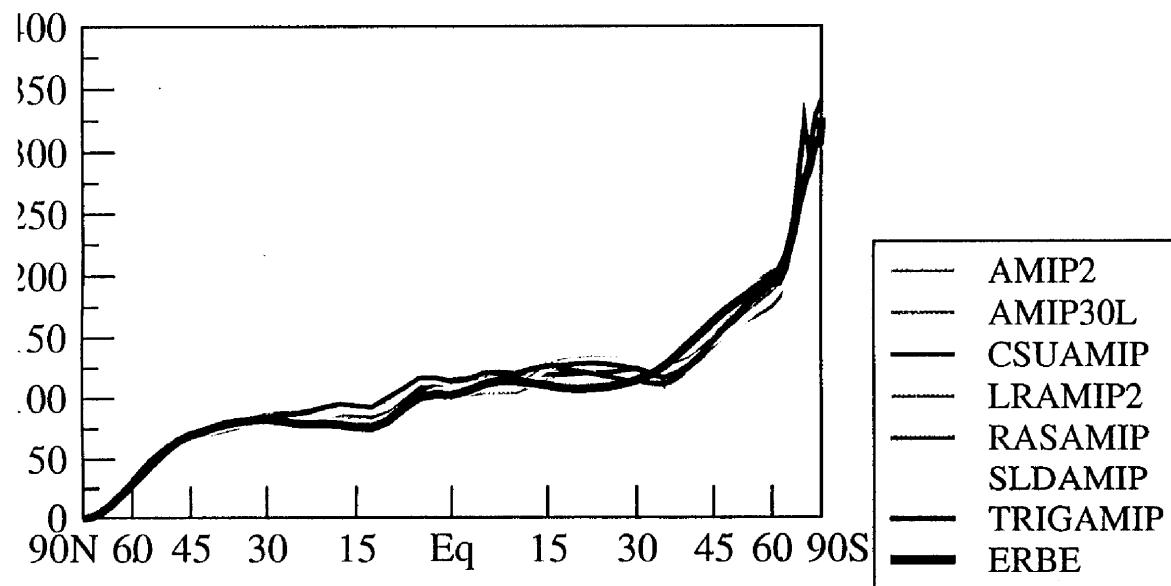
Latitude

**rlut: Normalized Total Error**  
**(Reference data set: ERBE)**

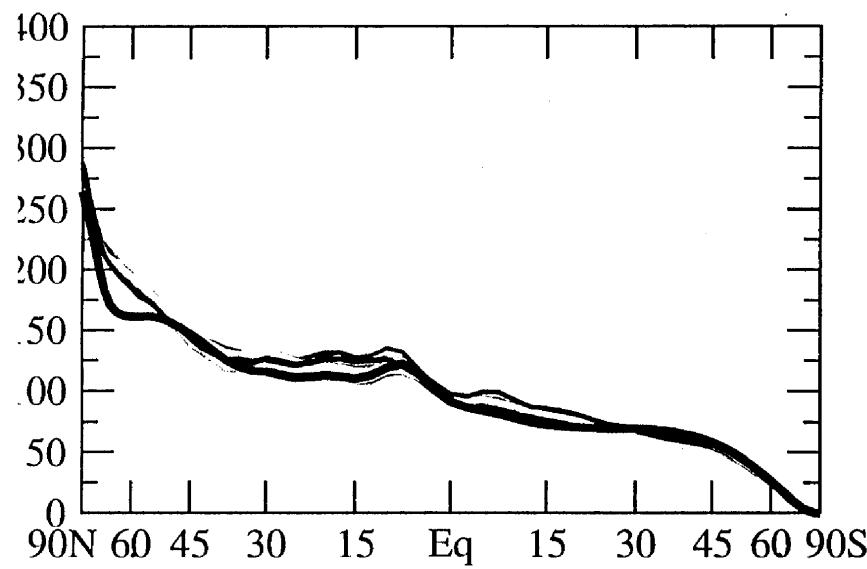


# SW radiation upward TOA

DJF Climatology

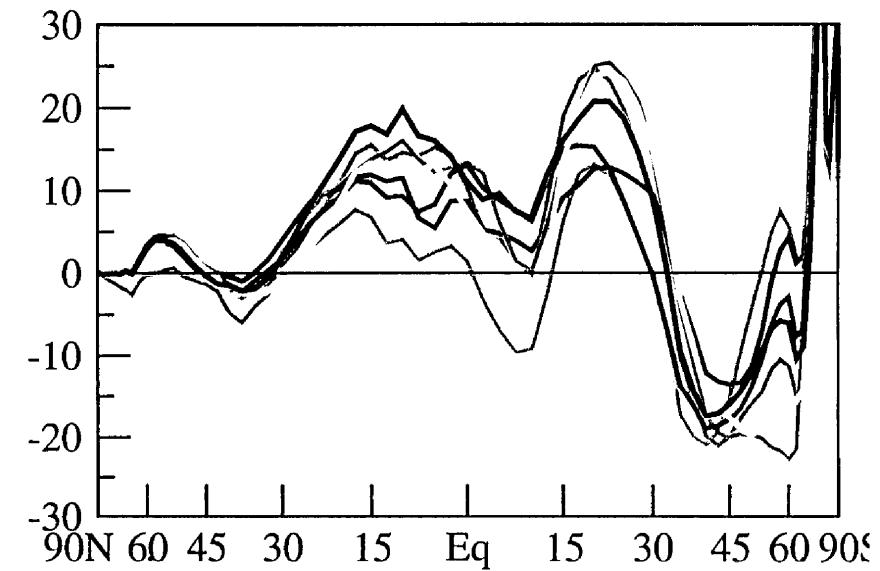


JJA Climatology

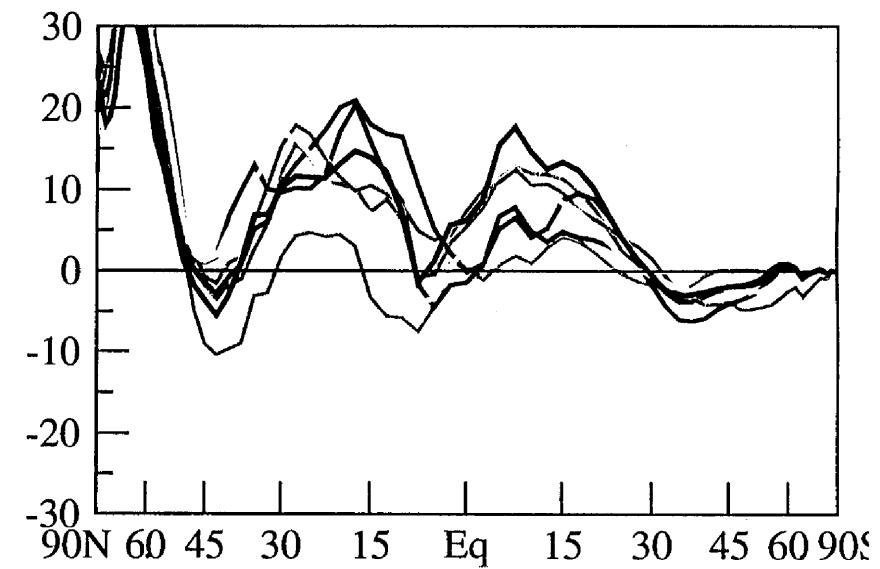


Latitude

DJF Models minus Reference

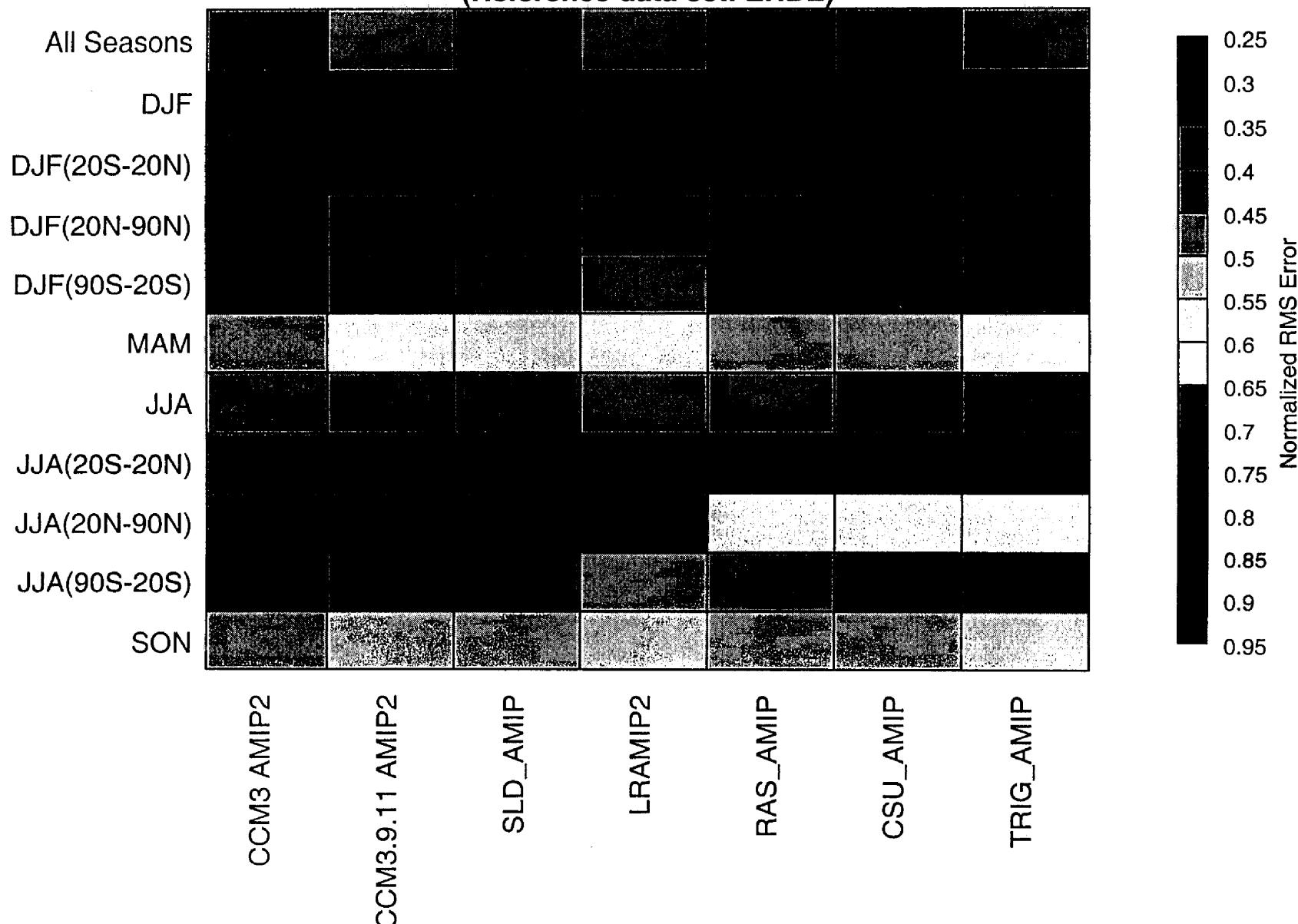


JJA Models minus Reference



Latitude

**rsut: Normalized Total Error**  
(Reference data set: ERBE)



# **CCM3.6\_AMIP2**

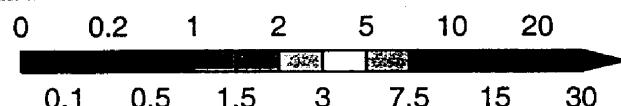
- Standard 18 level model
- T42, 18 levels
- “official” AMIP2 run as submitted to PCMDI.

# CCM3.6\_AMIP2

Total precipitation rate (mm/day)

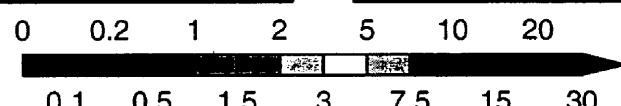
Observed (CPC, Xie-Arkin), DJF

Observed (CPC, Xie-Arkin), JJA

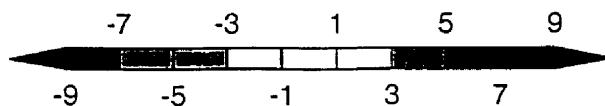
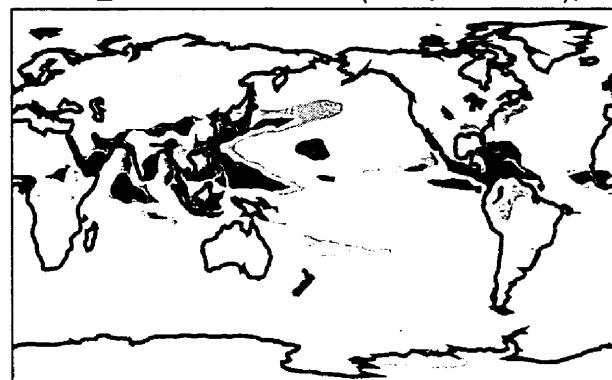
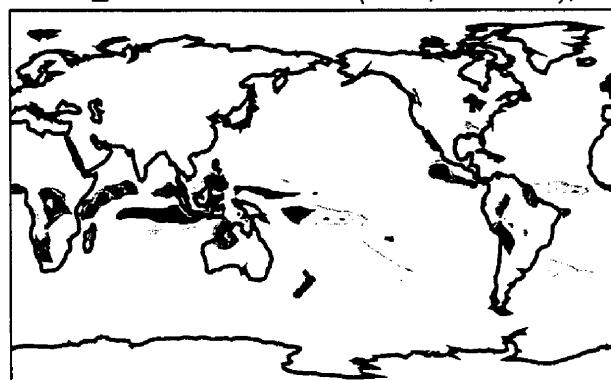


CCM3.6\_AMIP2, DJF

CCM3.6\_AMIP2, JJA



CCM3.6\_AMIP2 - Observed (CPC, Xie-Arkin), DJF CCM3.6\_AMIP2 - Observed (CPC, Xie-Arkin), JJA



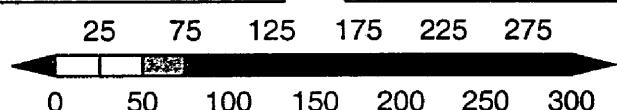
# CCM3.6\_AMIP2

Heat flux latent surface ( $\text{W/m}^2$ )

Observed (COADS), DJF



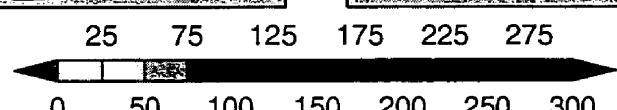
Observed (COADS), JJA



CCM3.6\_AMIP2, DJF



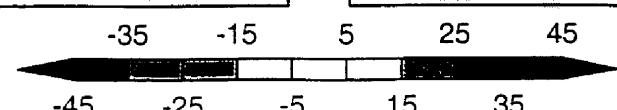
CCM3.6\_AMIP2, JJA



CCM3.6\_AMIP2 - Observed (COADS), DJF

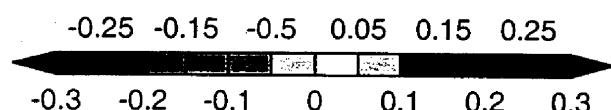
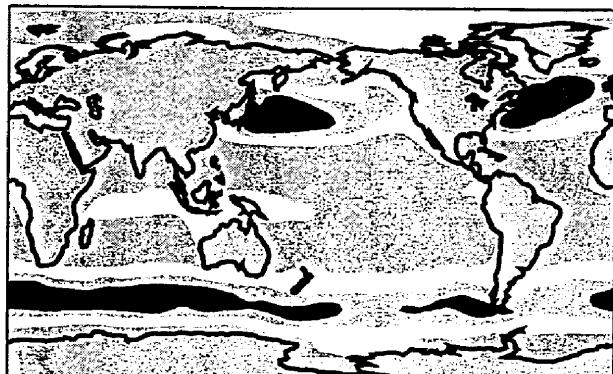


CCM3.6\_AMIP2 - Observed (COADS), JJA



# CCM3.6\_AMIP2

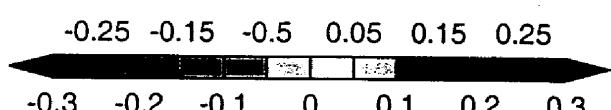
Eastward surface wind stress (positive for eastward wind) ( $N/m^2$ )  
UWMCOADS, DJF



CCM3.6\_AMIP2, DJF



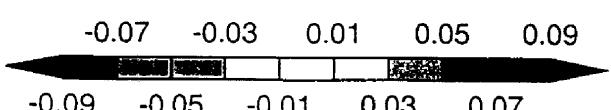
CCM3.6\_AMIP2, JJA



CCM3.6\_AMIP2 - UWMCOADS, DJF



CCM3.6\_AMIP2 - UWMCOADS, JJA



# CCM3.6\_AMIP2

LW radiation TOA (OLR) (W/m<sup>2</sup>)

Observed (ERBE), DJF



Observed (ERBE), JJA



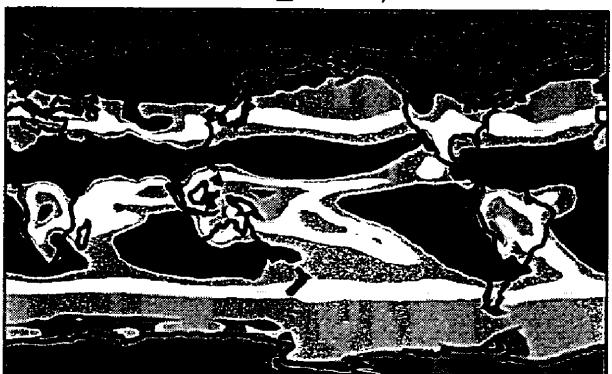
120 160 200

240 280 320

100 140 180 220

260 300 340

CCM3.6\_AMIP2, DJF



CCM3.6\_AMIP2, JJA



120 160 200

240 280 320

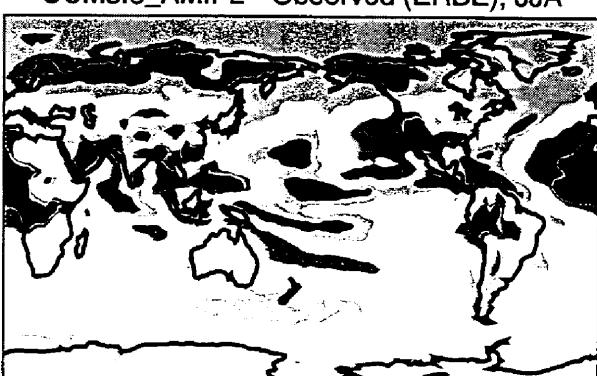
100 140 180 220

260 300 340

CCM3.6\_AMIP2 - Observed (ERBE), DJF



CCM3.6\_AMIP2 - Observed (ERBE), JJA



-35 -15

5 25 45

-45 -25 -5

15 35

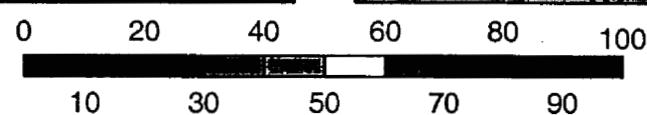
# CCM3.6\_AMIP2

Total Cloud Amount (%)

Observed (ISCCP), DJF



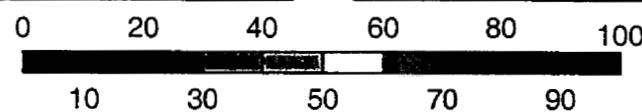
Observed (ISCCP), JJA



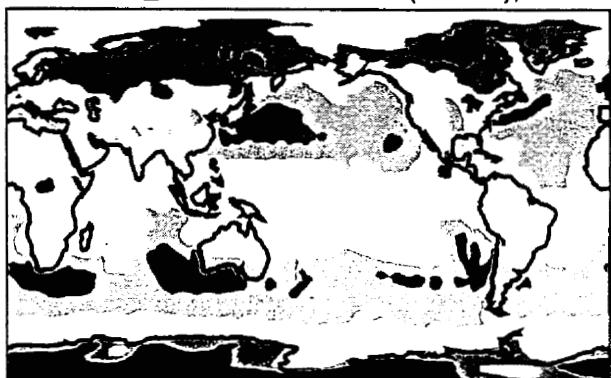
CCM3.6\_AMIP2, DJF



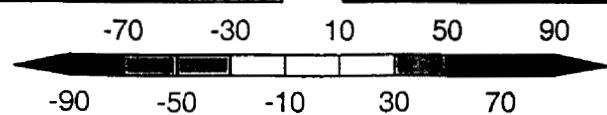
CCM3.6\_AMIP2, JJA



CCM3.6\_AMIP2 - Observed (ISCCP), DJF



CCM3.6\_AMIP2 - Observed (ISCCP), JJA



# CCM3.6\_AMIP2

Sea Level Pressure (hPa)

Observed (ECMWF Reanalysis), DJF



Observed (ECMWF Reanalysis), JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

CCM3.6\_AMIP2, DJF



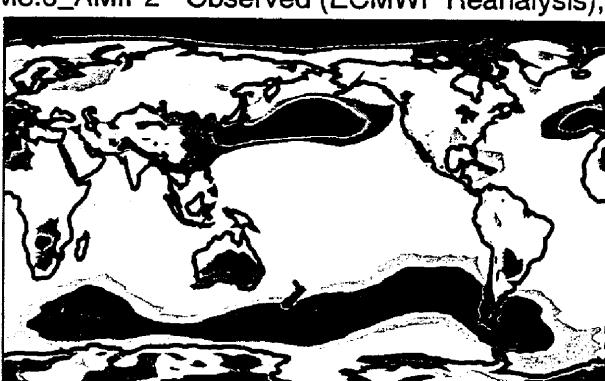
CCM3.6\_AMIP2, JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

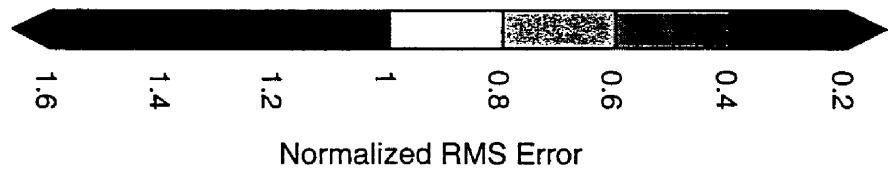
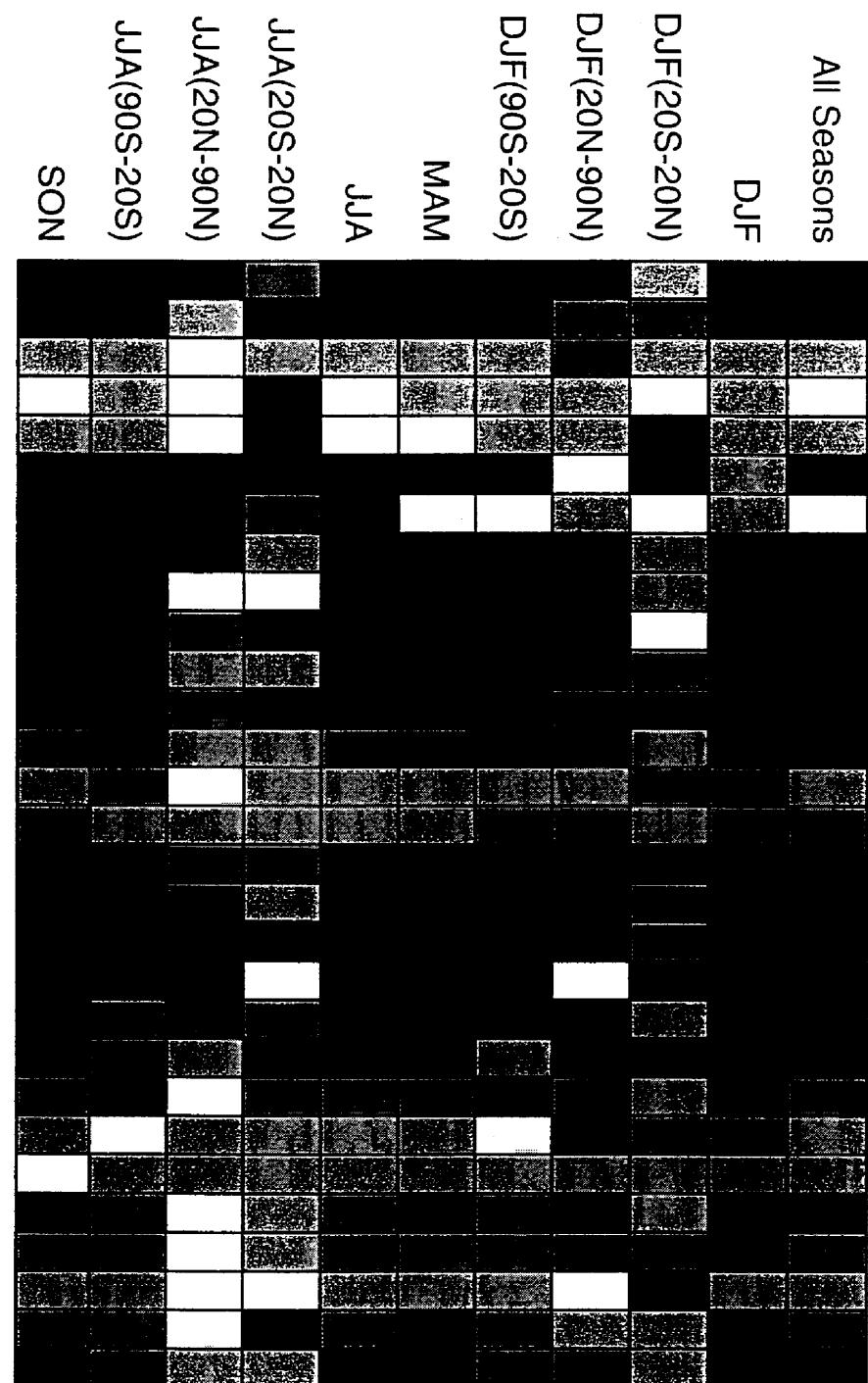
CCM3.6\_AMIP2 - Observed (ECMWF Reanalysis), DJF



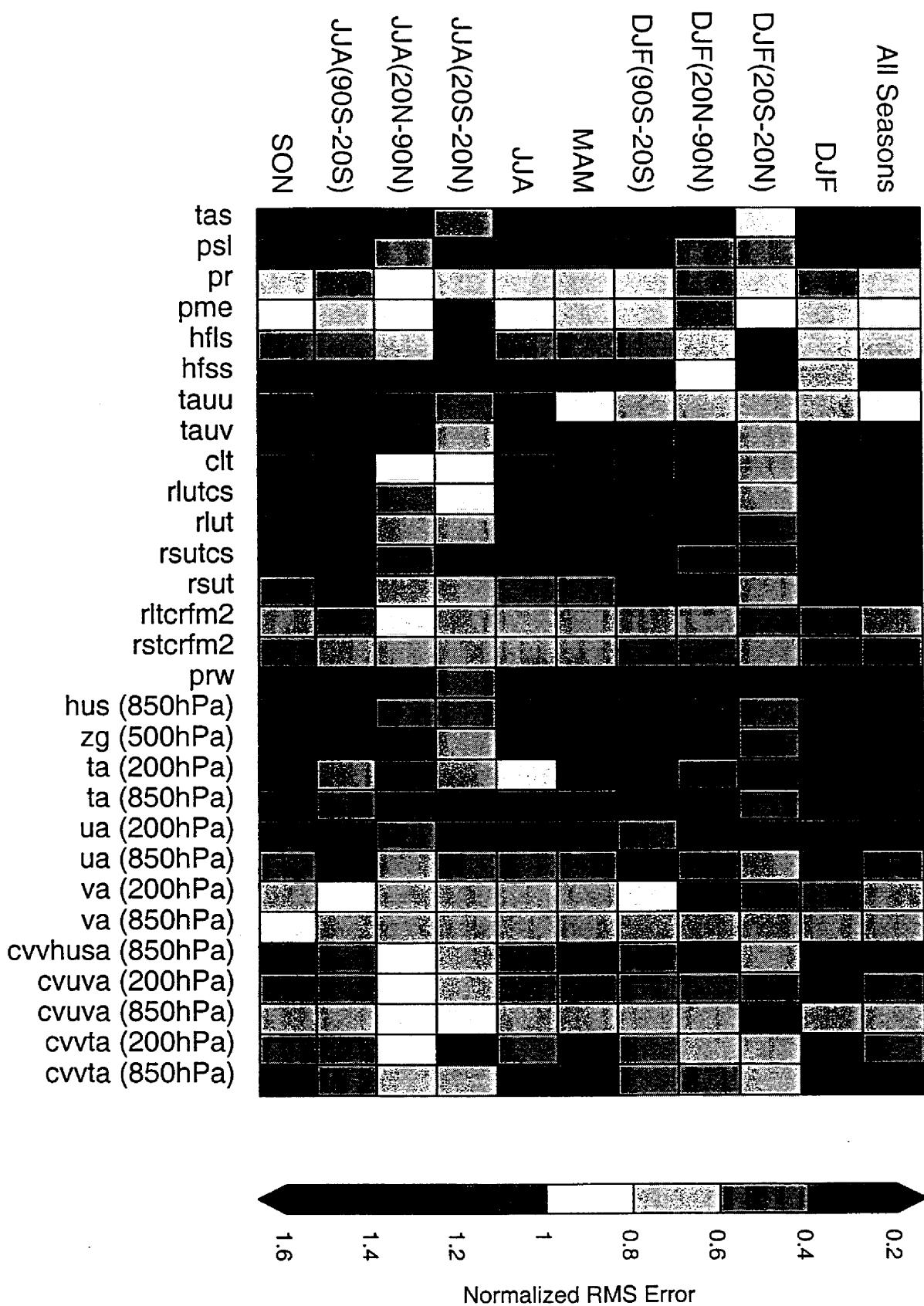
-7 -3 1 5 9

-9 -5 -1 3 7

## CCM3 AMIP2 Normalized Total Error

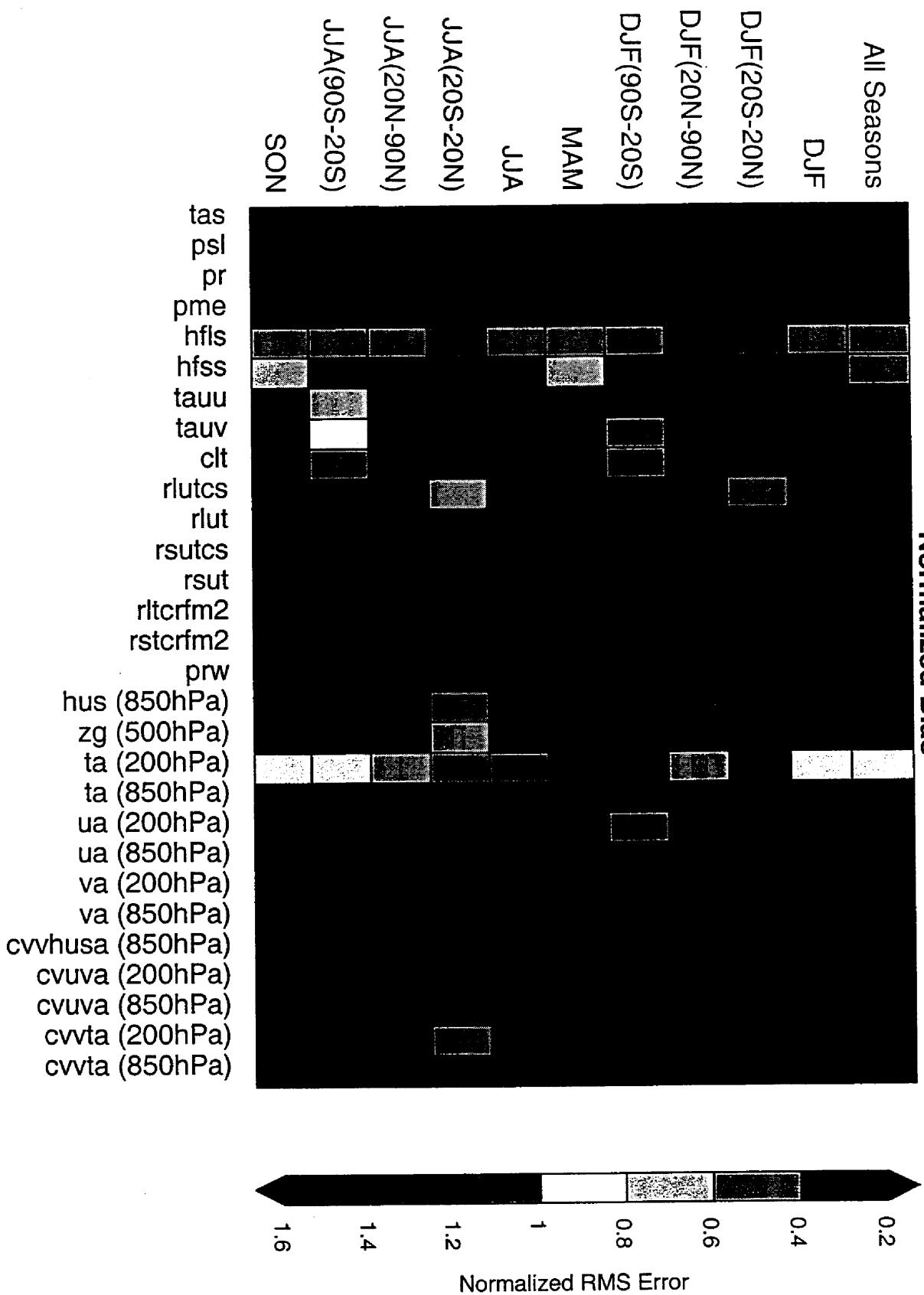


## CCM3 AMIP2 Normalized RMS Pattern Error



CCM3 AMIP2  
Normalized Bias

**PCMDI**  
Nov 30, 2000



# **CCM3.9.11\_AMIP2**

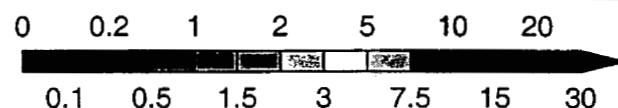
- Standard 30 level model released as CCM version 3.10
- T42, 30 levels
- AMIP2 run

# CCM3.9.11\_AMIP2

Total precipitation rate (mm/day)

Observed (CPC, Xie-Arkin), DJF

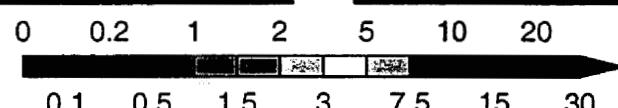
Observed (CPC, Xie-Arkin), JJA



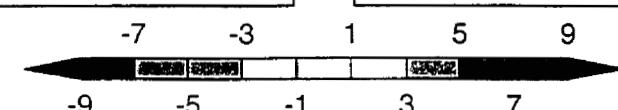
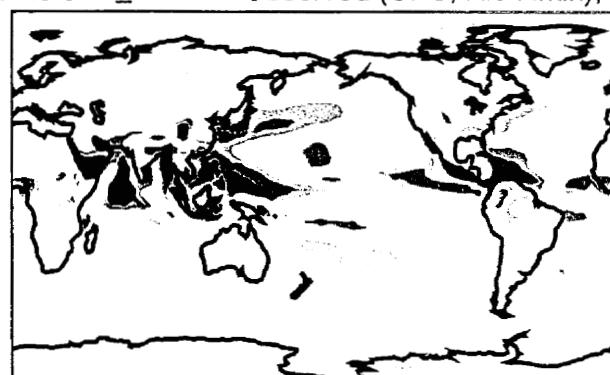
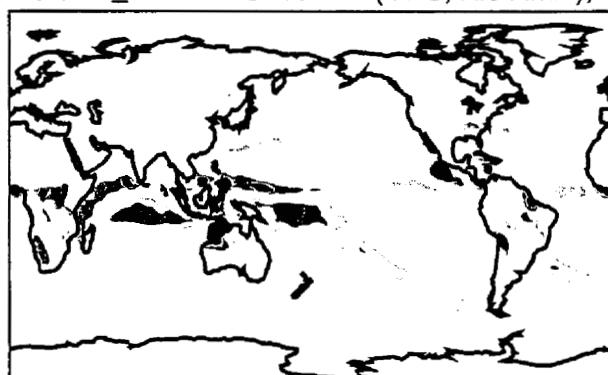
CCM3.9.11\_AMIP2, DJF



CCM3.9.11\_AMIP2, JJA

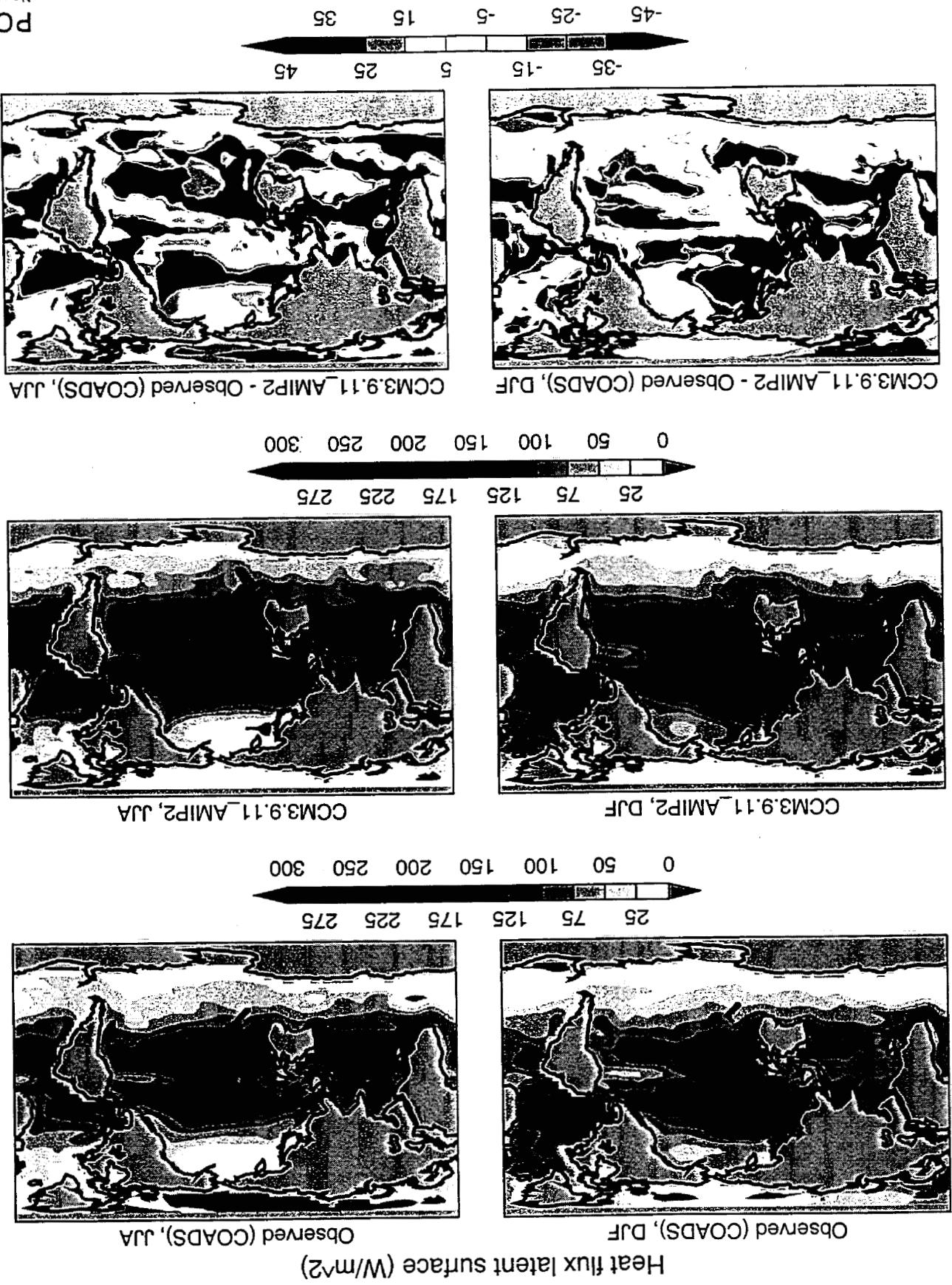


CCM3.9.11\_AMIP2 - Observed (CPC, Xie-Arkin), DJF



# CCM3.9.11\_AMIP2

NOV 22, 2000  
PCMDI



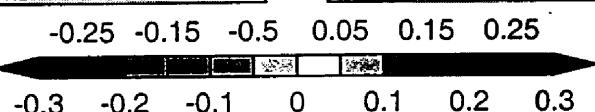
# CCM3.9.11\_AMIP2

Eastward surface wind stress (positive for eastward wind) ( $\text{N}/\text{m}^2$ )

UWMCOADS, DJF



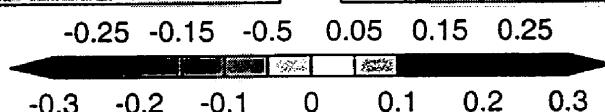
UWMCOADS, JJA



CCM3.9.11\_AMIP2, DJF



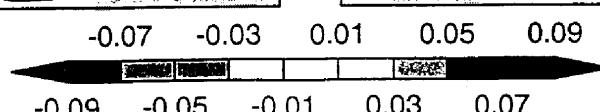
CCM3.9.11\_AMIP2, JJA



CCM3.9.11\_AMIP2 - UWMCOADS, DJF



CCM3.9.11\_AMIP2 - UWMCOADS, JJA



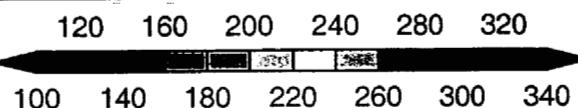
# CCM3.9\_11\_AMIP2

LW radiation TOA (OLR) (W/m<sup>2</sup>)

Observed (ERBE), DJF



Observed (ERBE), JJA



CCM3.9.11\_AMIP2, DJF



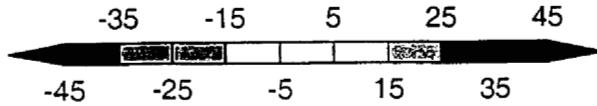
CCM3.9.11\_AMIP2, JJA



CCM3.9.11\_AMIP2 - Observed (ERBE), DJF



CCM3.9.11\_AMIP2 - Observed (ERBE), JJA

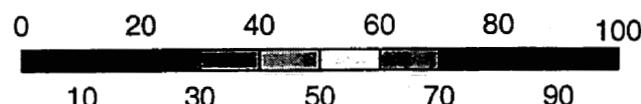


# CCM3.9.11\_AMIP2

Total Cloud Amount (%)

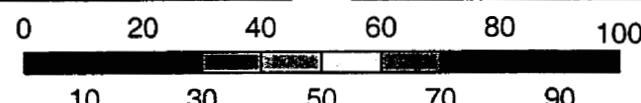
Observed (ISCCP), DJF

Observed (ISCCP), JJA



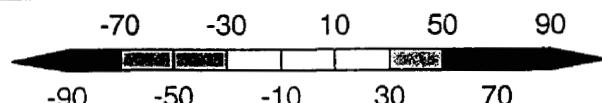
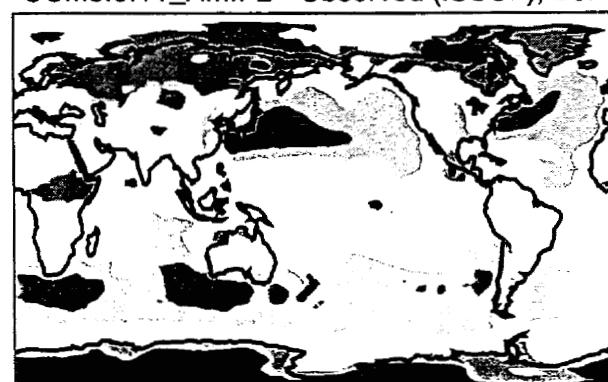
CCM3.9.11\_AMIP2, DJF

CCM3.9.11\_AMIP2, JJA



CCM3.9.11\_AMIP2 - Observed (ISCCP), DJF

CCM3.9.11\_AMIP2 - Observed (ISCCP), JJA



# CCM3.9.11\_AMIP2

Sea Level Pressure (hPa)

Observed (ECMWF Reanalysis), DJF



Observed (ECMWF Reanalysis), JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

CCM3.9.11\_AMIP2, DJF



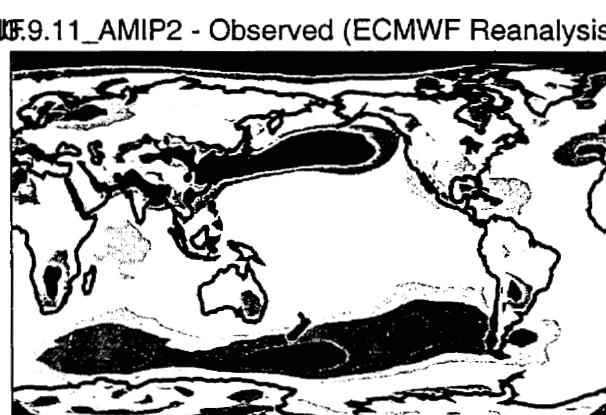
CCM3.9.11\_AMIP2, JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

CCM3.9.11\_AMIP2 - Observed (ECMWF Reanalysis), DJF



-7 -3 1 5 9

-9 -5 -1 3 7

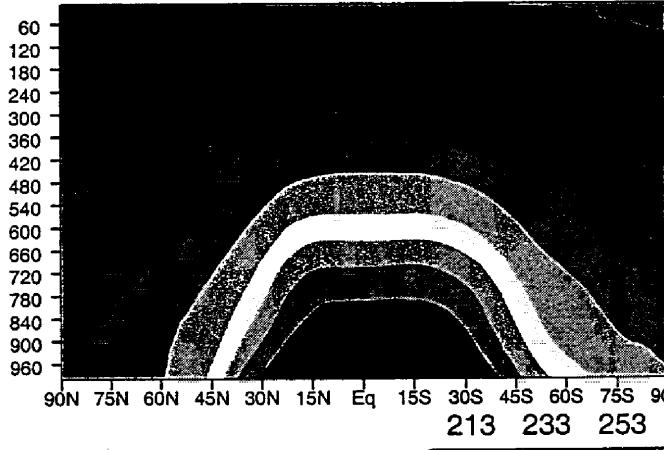
PCMDI

Nov 22, 2000

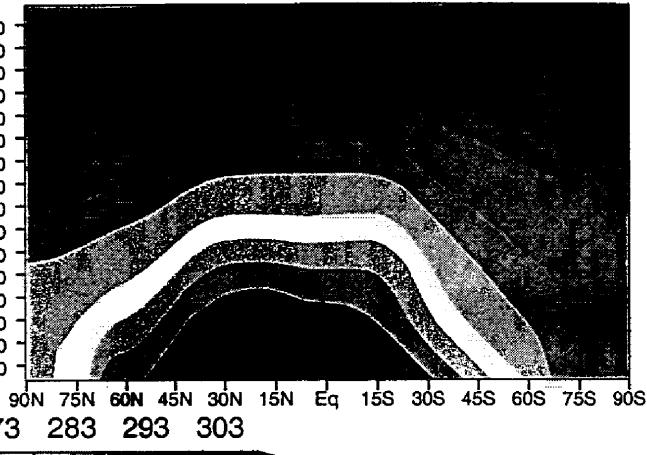
# CCM3.9.11\_AMIP2

Air Temperature

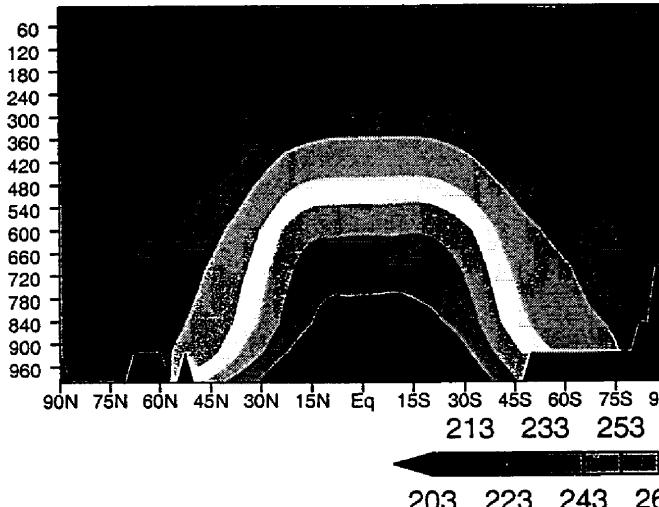
ECMWF reanalysis DJF



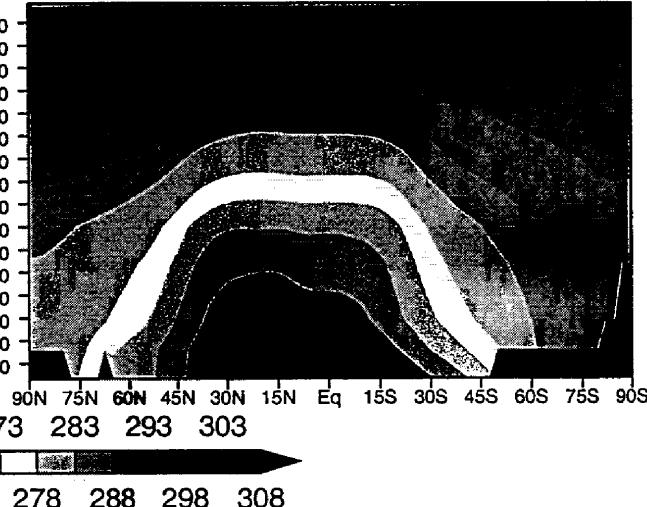
ECMWF reanalysis JJA



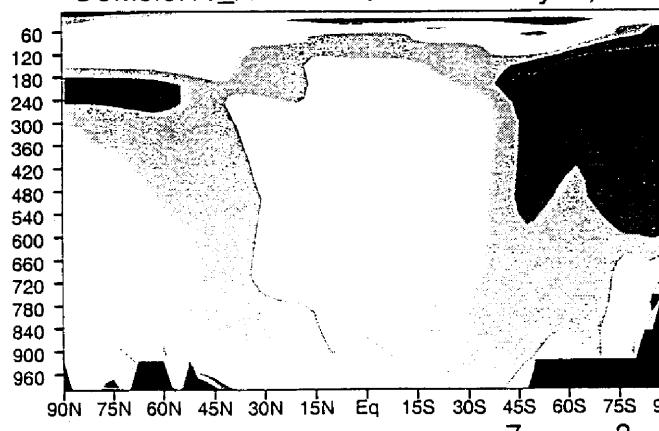
CCM3.9.11\_AMIP2 DJF



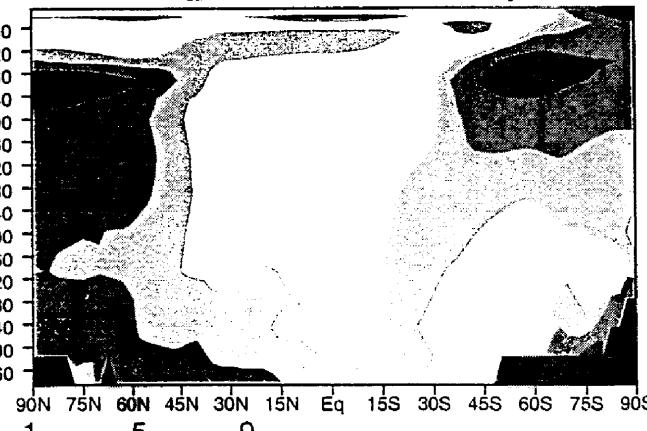
CCM3.9.11\_AMIP2 JJA



CCM3.9.11\_AMIP2- ECMWF reanalysis, DJF



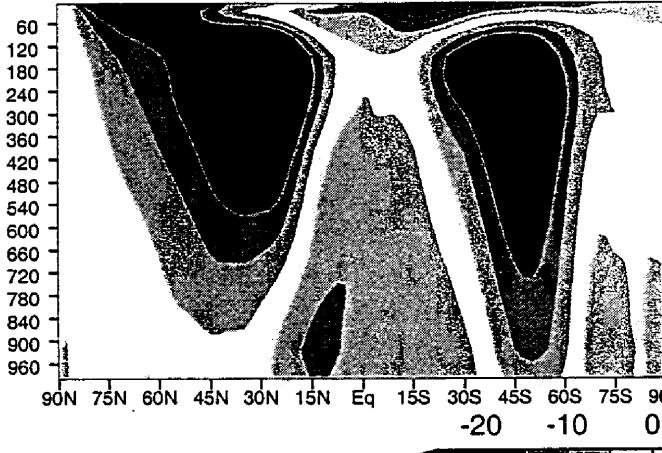
CCM3.9.11\_AMIP2- ECMWF reanalysis, JJA



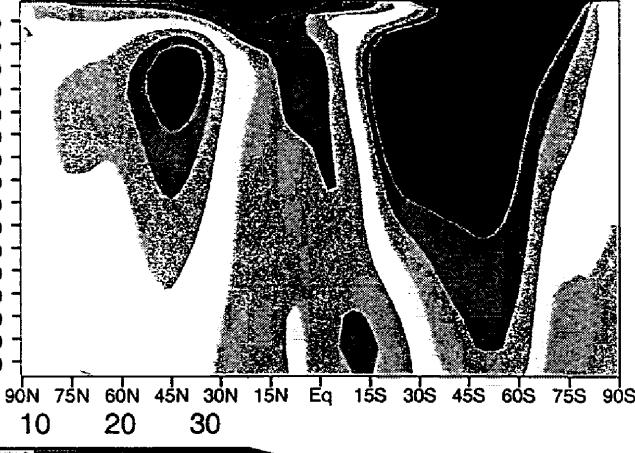
# CCM3.9.11\_AMIP2

Eastward wind

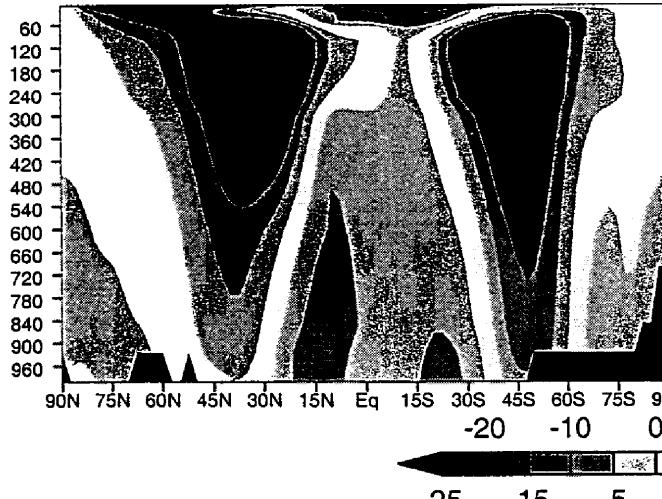
ECMWF reanalysis DJF



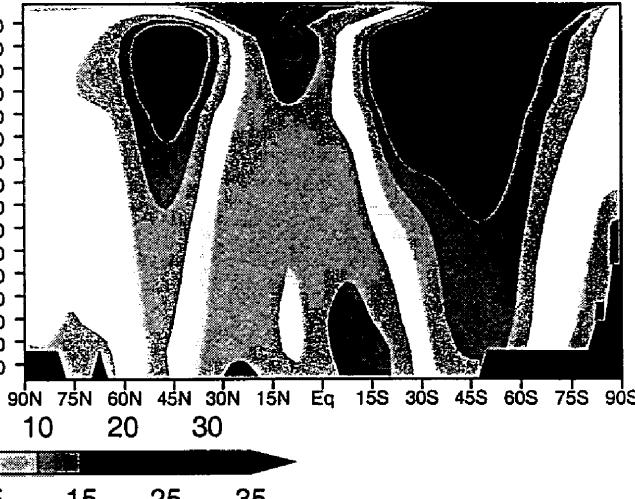
ECMWF reanalysis JJA



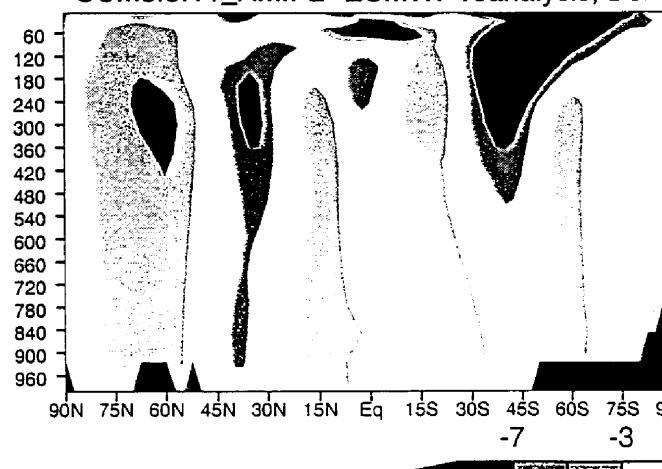
CCM3.9.11\_AMIP2 DJF



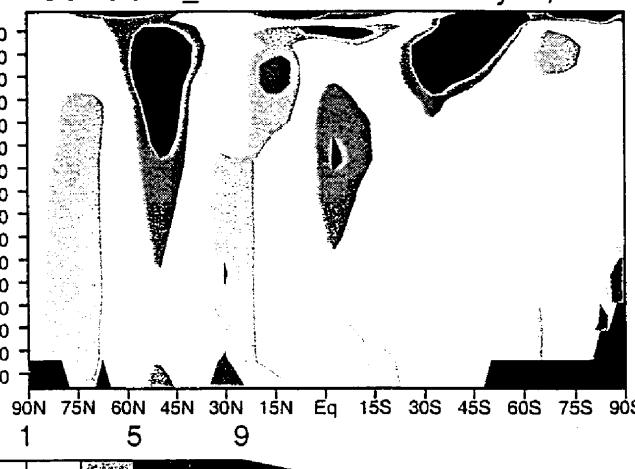
CCM3.9.11\_AMIP2 JJA



CCM3.9.11\_AMIP2- ECMWF reanalysis, DJF

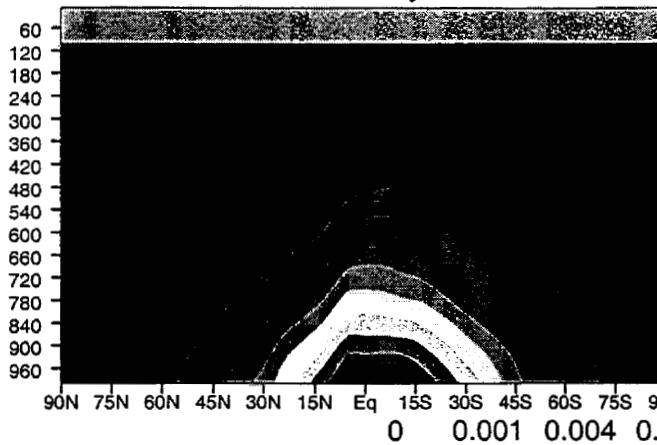


CCM3.9.11\_AMIP2- ECMWF reanalysis, JJA

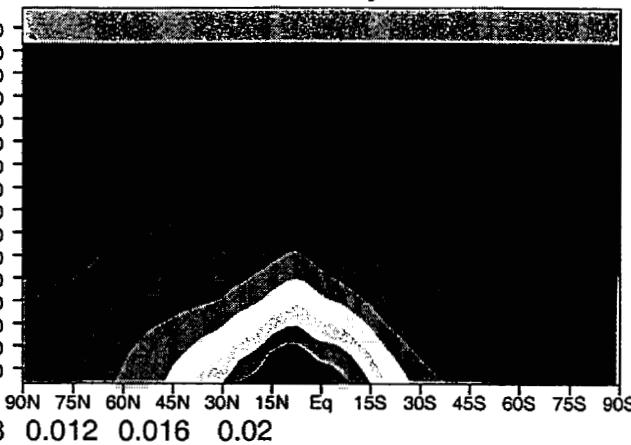


Specific humidity

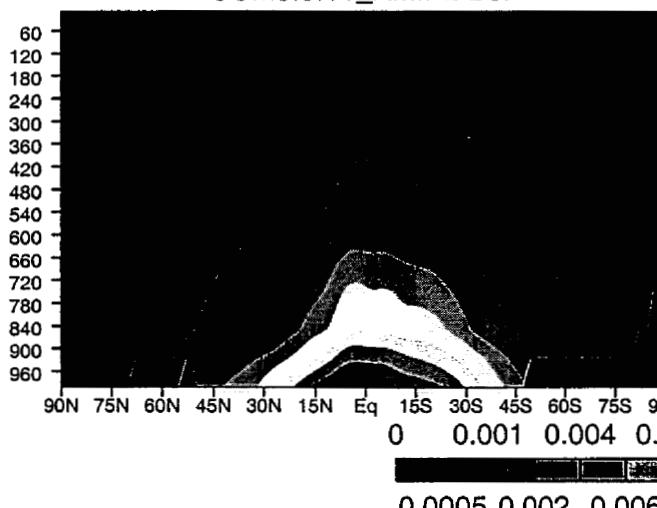
ECMWF reanalysis DJF



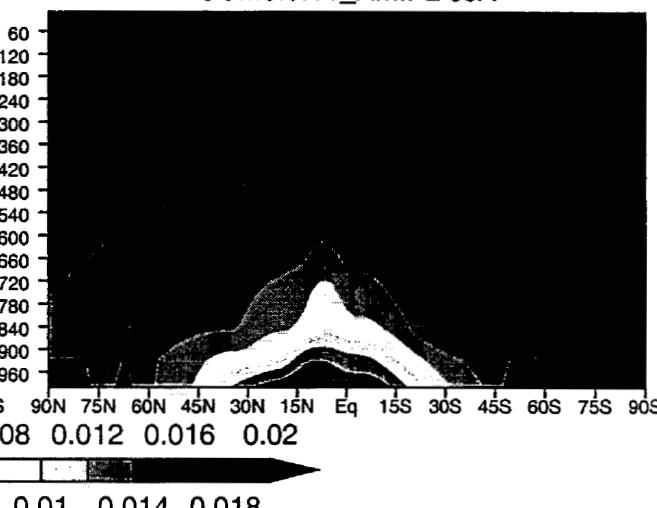
ECMWF reanalysis JJA



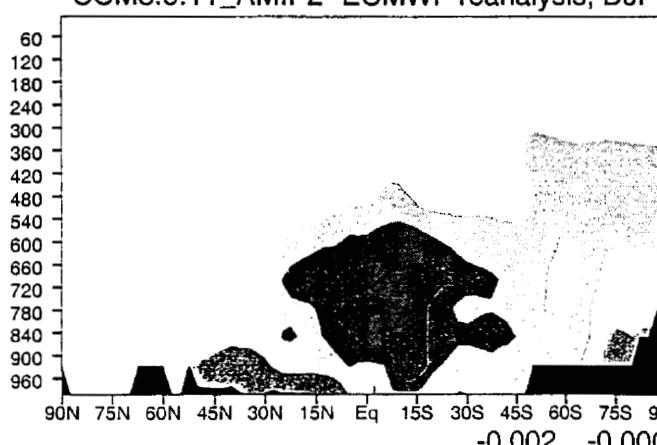
CCM3.9.11\_AMIP2 DJF



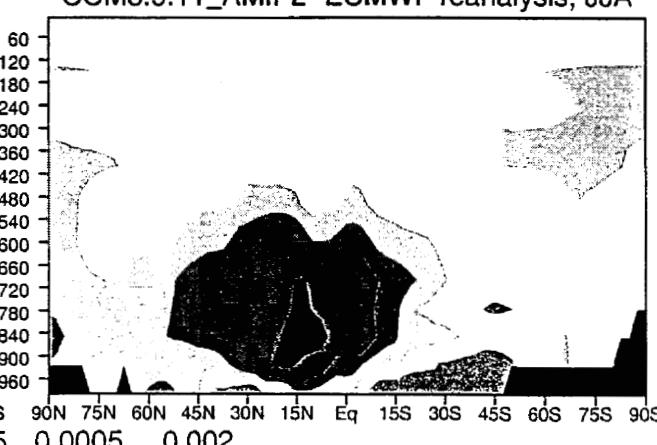
CCM3.9.11\_AMIP2 JJA



CCM3.9.11\_AMIP2- ECMWF reanalysis, DJF



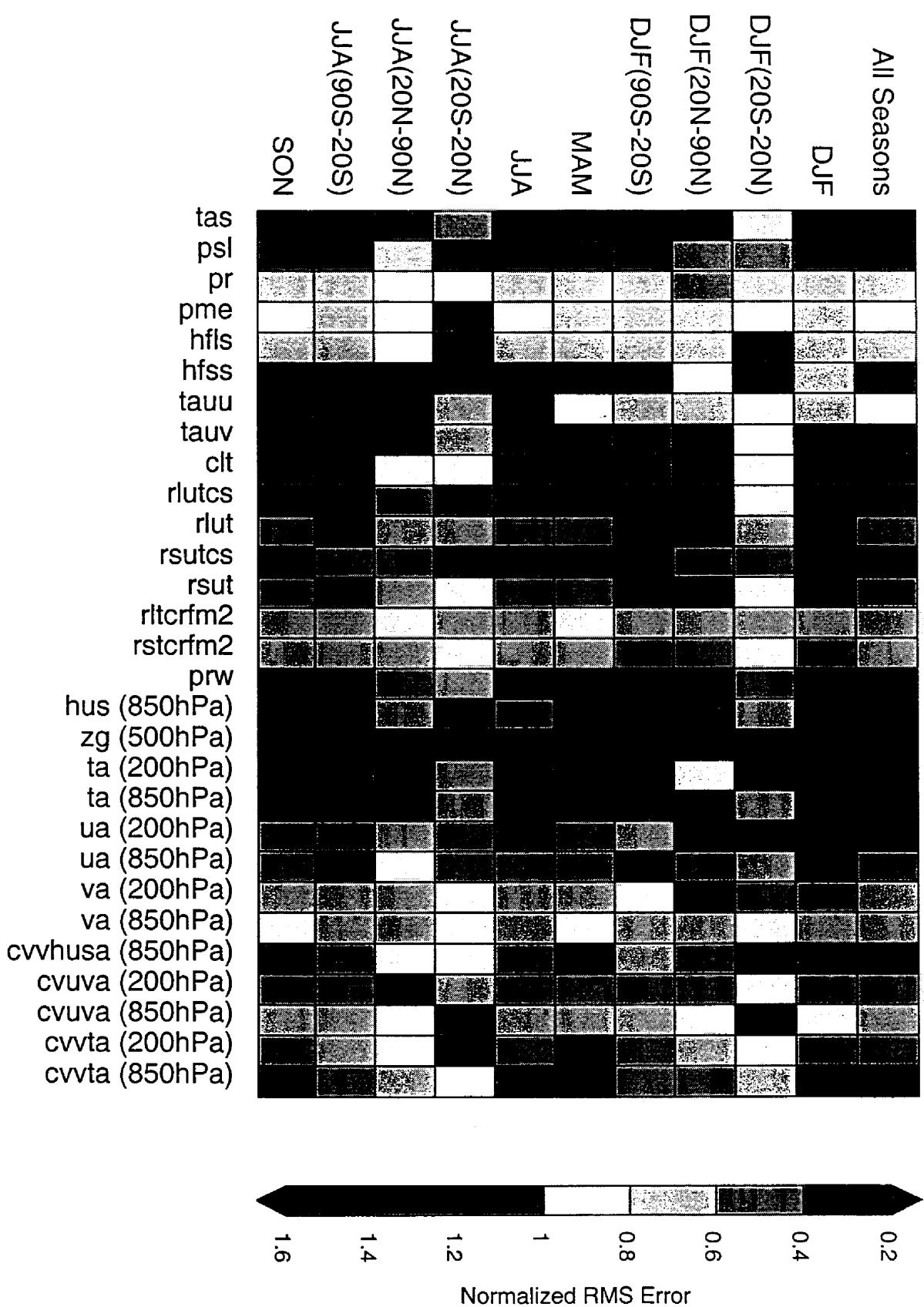
CCM3.9.11\_AMIP2- ECMWF reanalysis, JJA



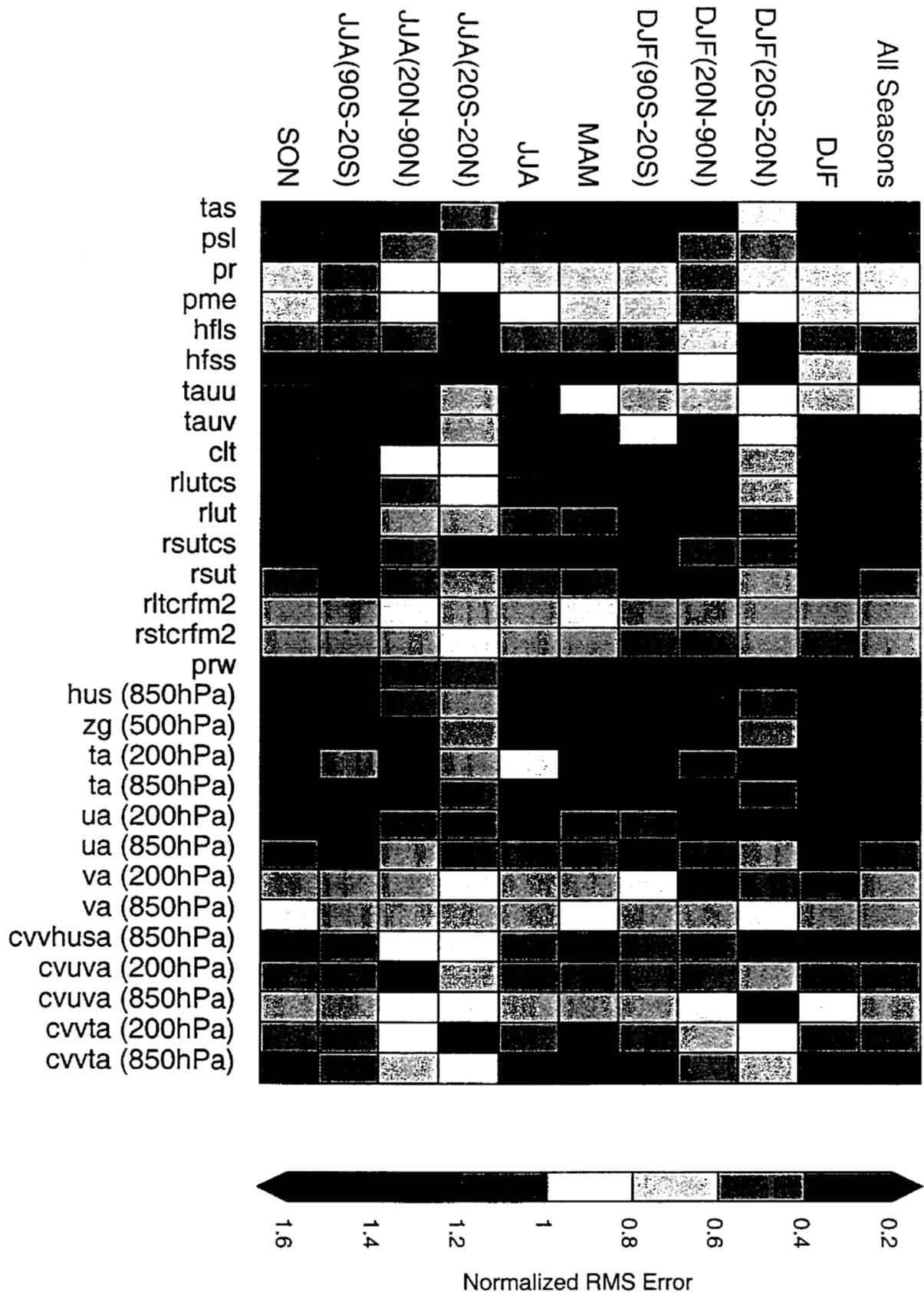
# CCM3.9.11 AMIP2

## Normalized Total Error

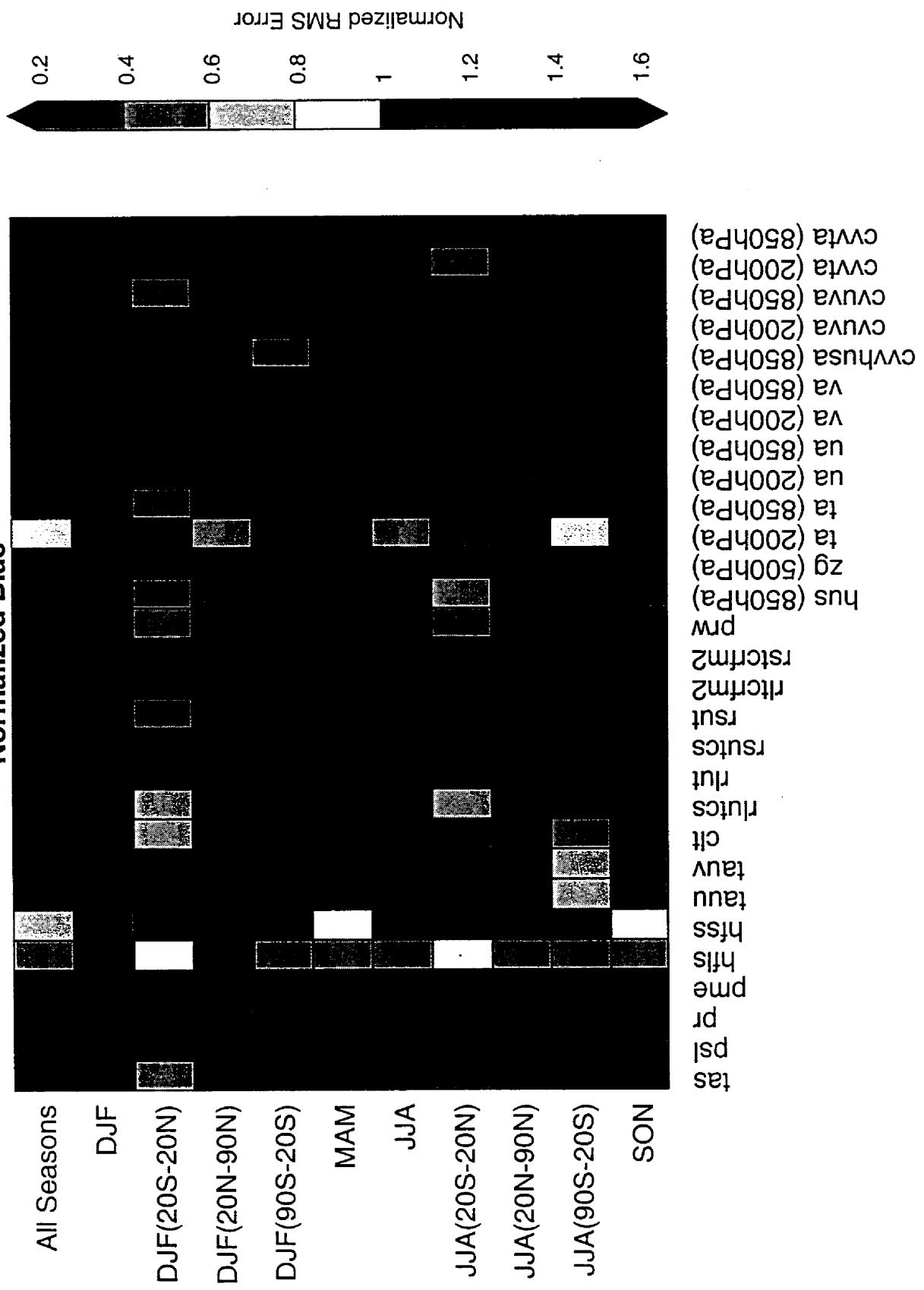
PCMDI  
Nov 30, 2000



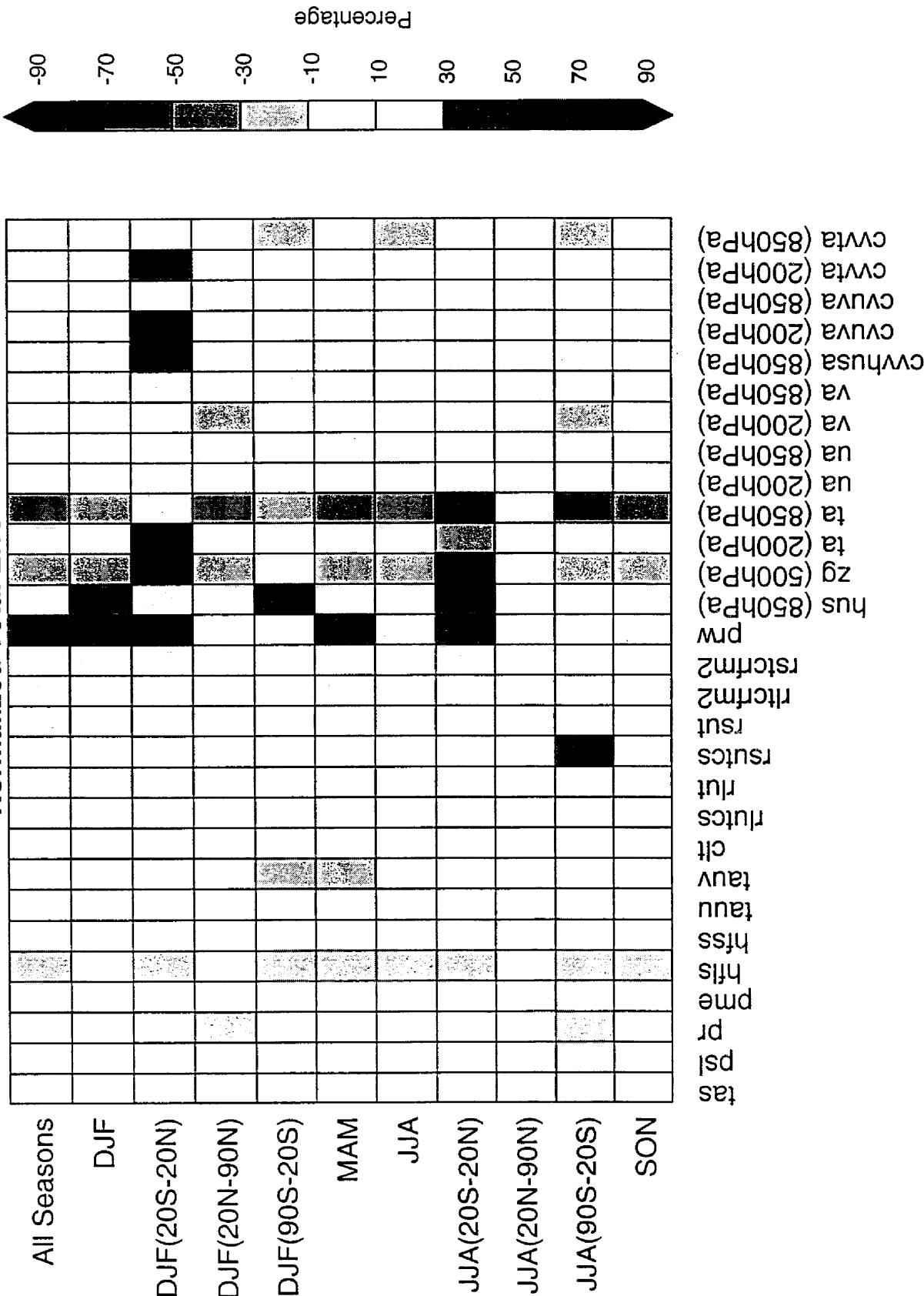
## CCM3.9.11 AMIP2 Normalized RMS Pattern Error



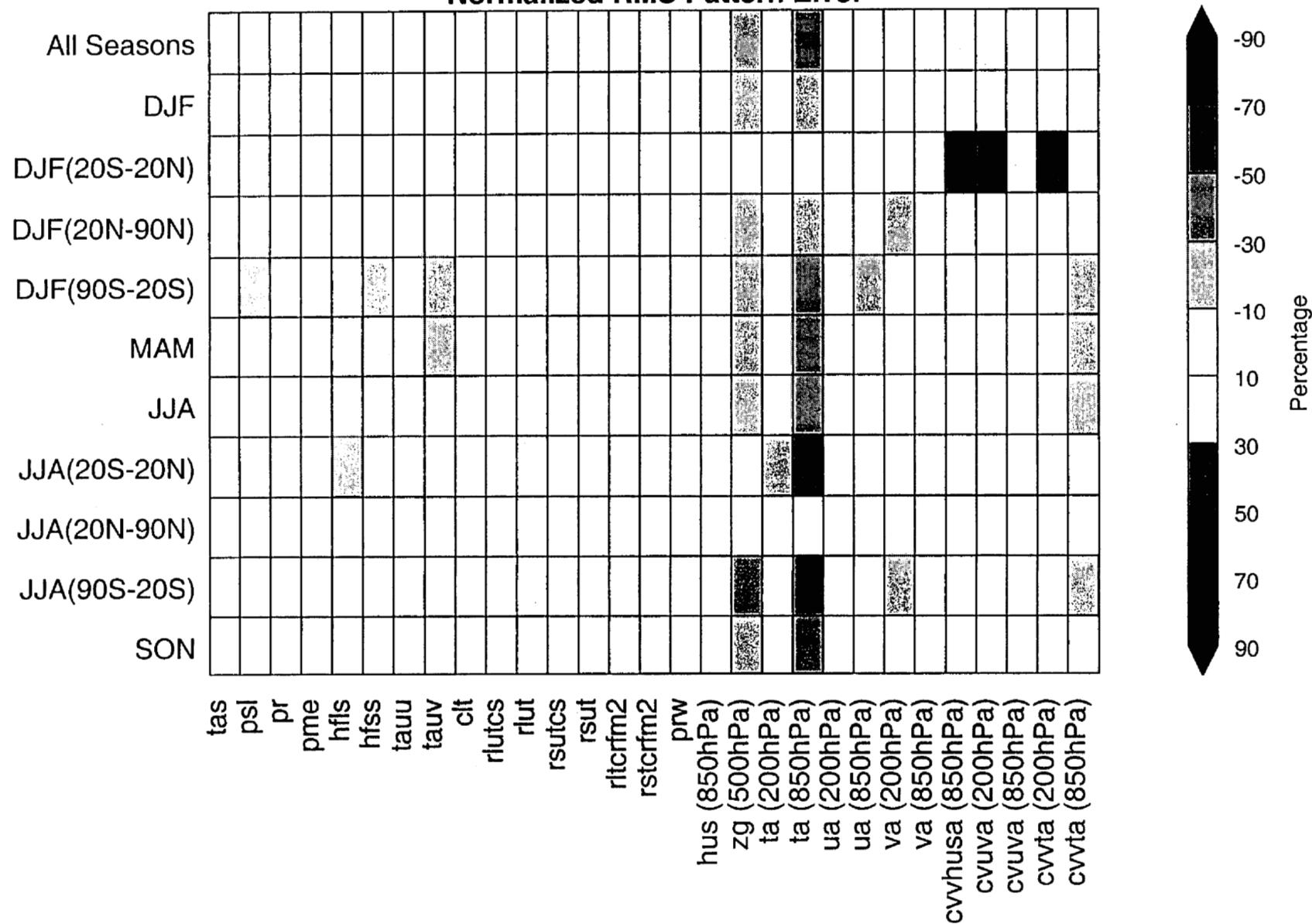
## CCM3.9.11 AMIP2 Normalized Bias



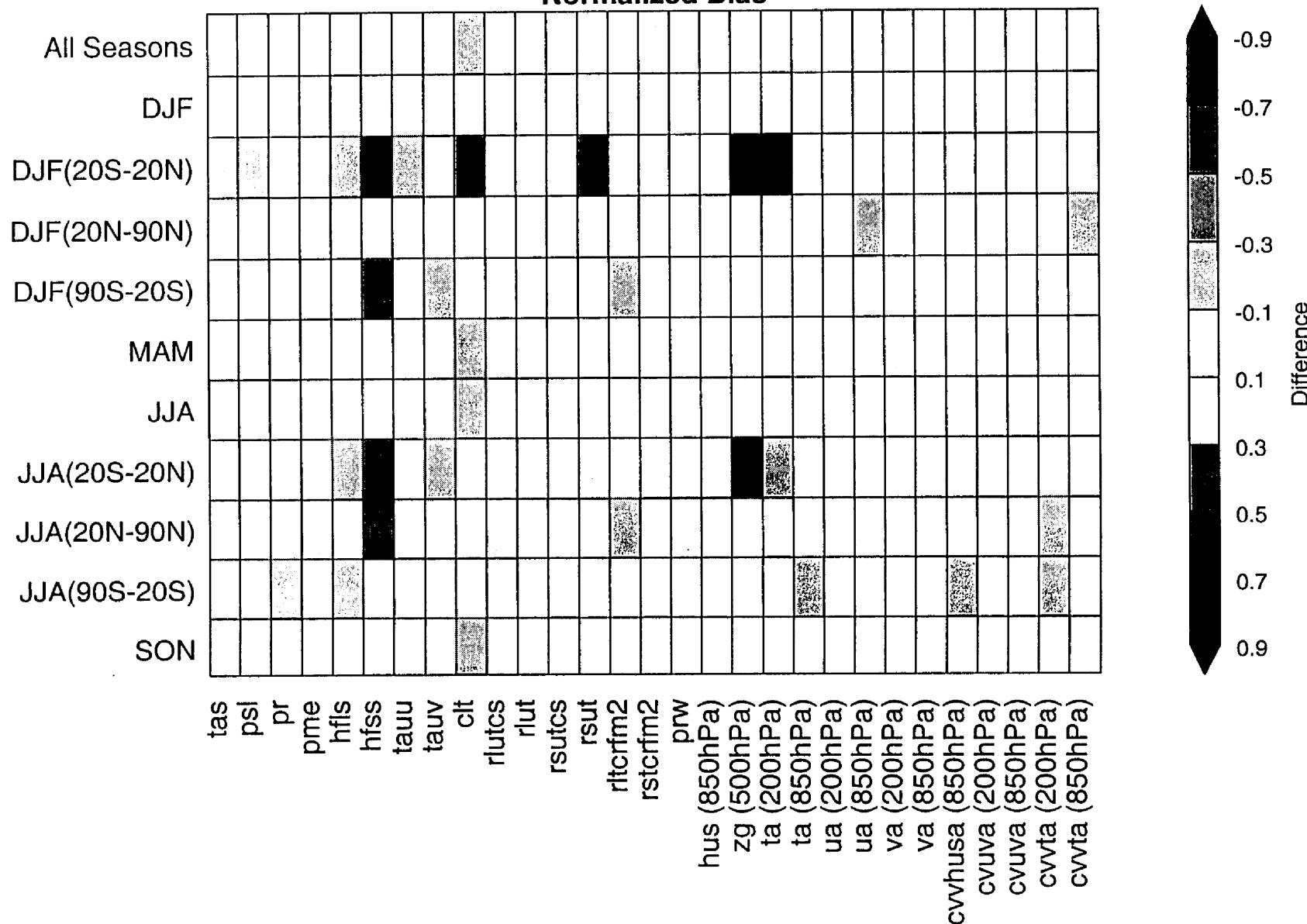
## CCM3.9.11 AMIP2: Percentage Difference from CCM3 AMIP2 Normalized Total Error



## CCM3.9.11 AMIP2: Percentage Difference from CCM3 AMIP2 Normalized RMS Pattern Error

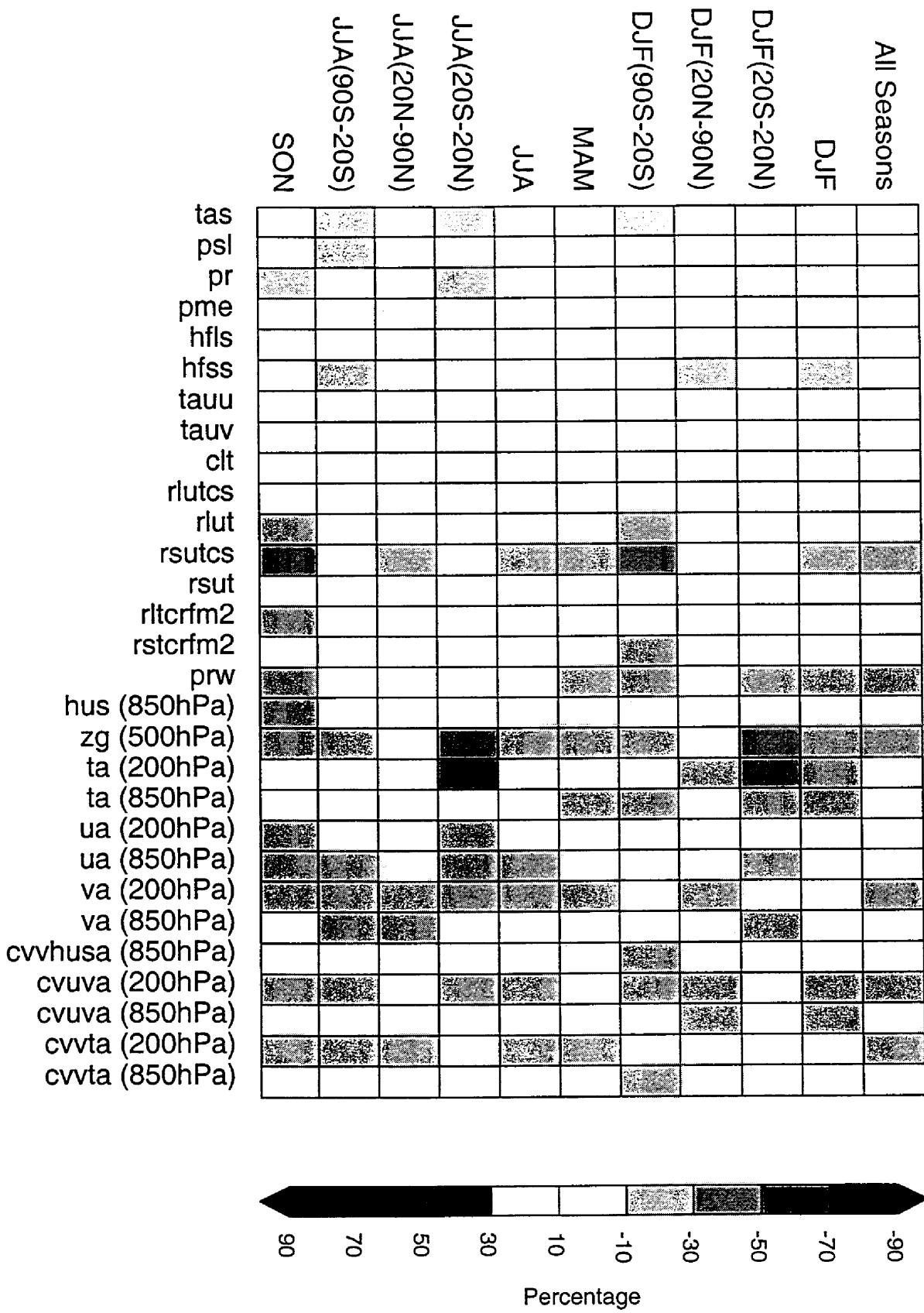


## CCM3.9.11 AMIP2: Absolute Difference from CCM3 AMIP2 Normalized Bias

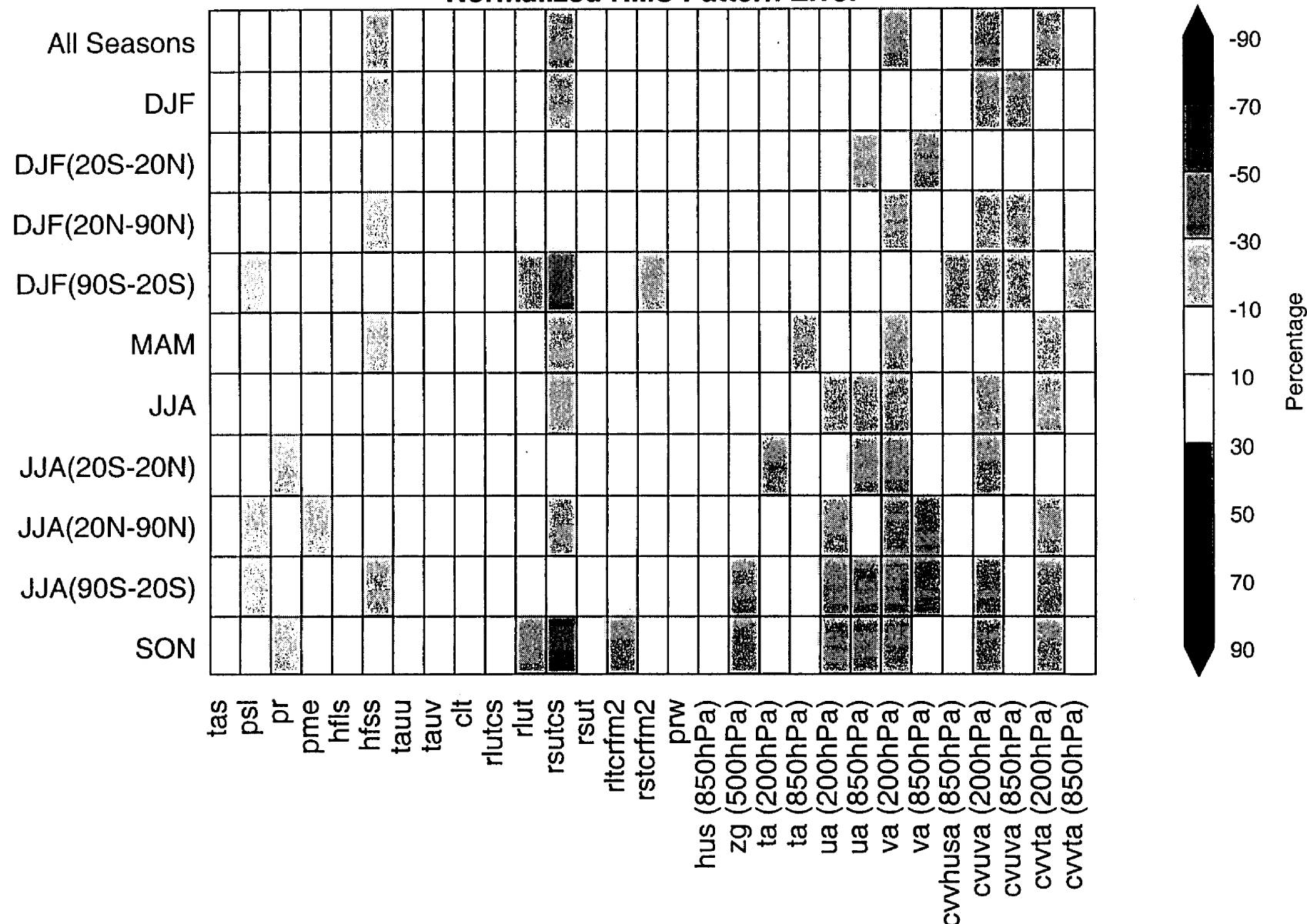


# AMIP30L: Percentage Difference from CCM3.9.11 (CAM0.1)

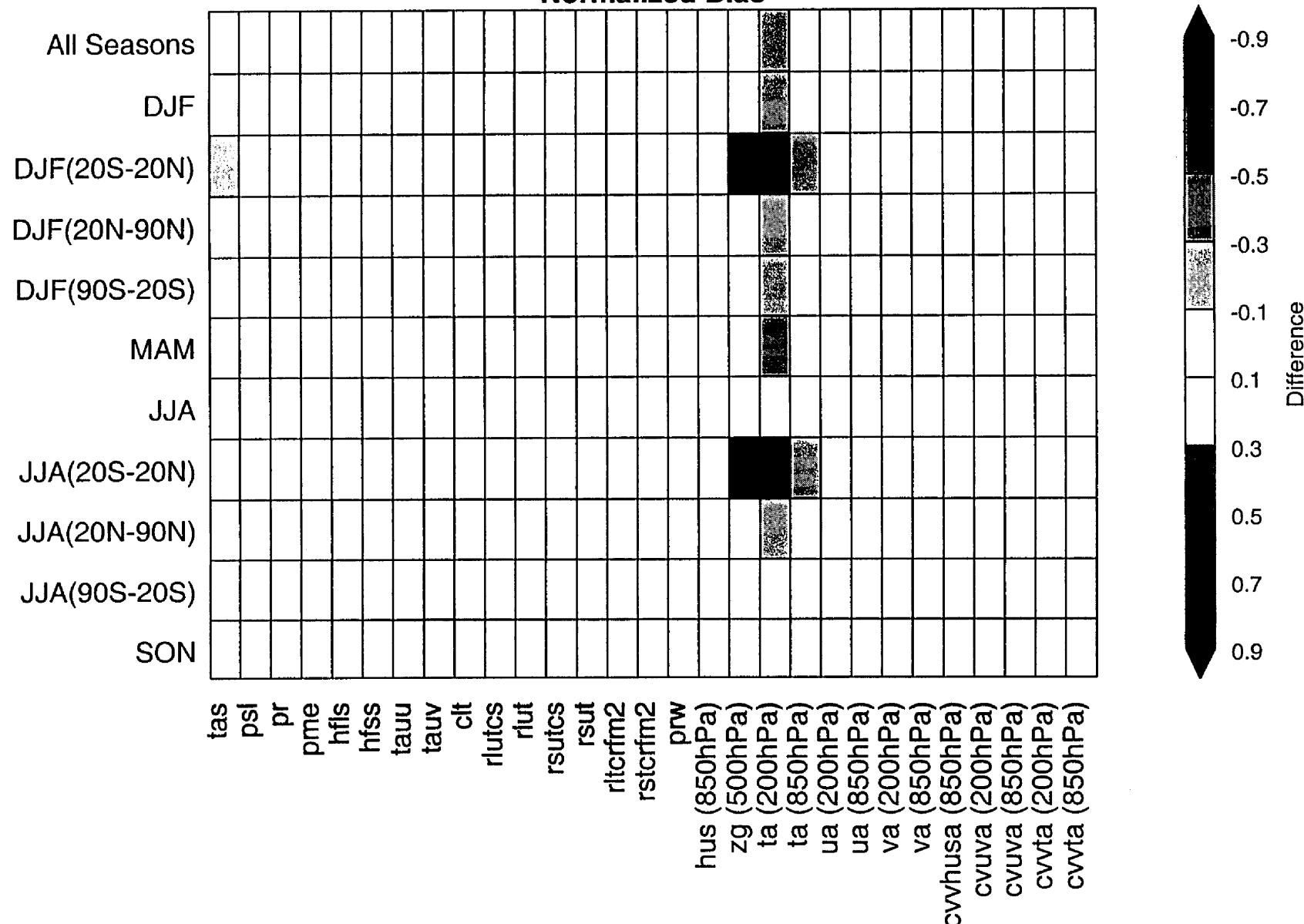
PCMDI  
Nov 28, 2000



## AMIP30L: Percentage Difference from CCM3.9.11 (CAM0.1) Normalized RMS Pattern Error



## AMIP30L: Absolute Difference from CCM3.9.11 (CAM0.1) Normalized Bias



# **SLD\_AMIP2**

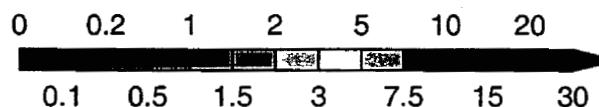
- CCM 3.10 physics with semi-lagrangian dynamics.
- T42, 30 levels
- AMIP2 run
- Contact: Dave Williamson, NCAR,  
[wmson@ucar.edu](mailto:wmson@ucar.edu)

# SLD\_AMIP2

Total precipitation rate (mm/day)

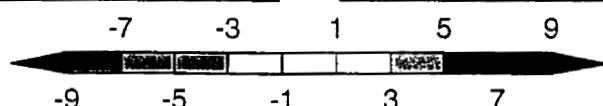
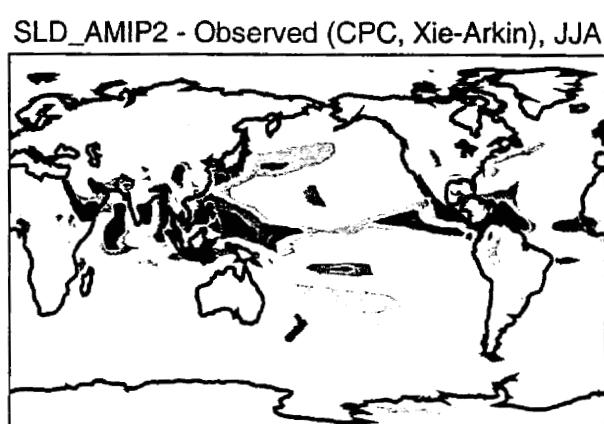
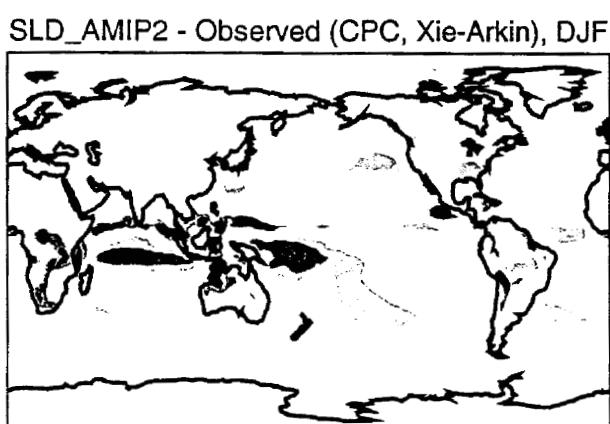
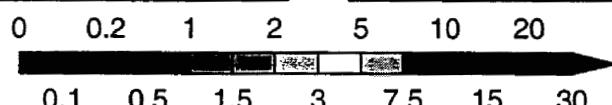
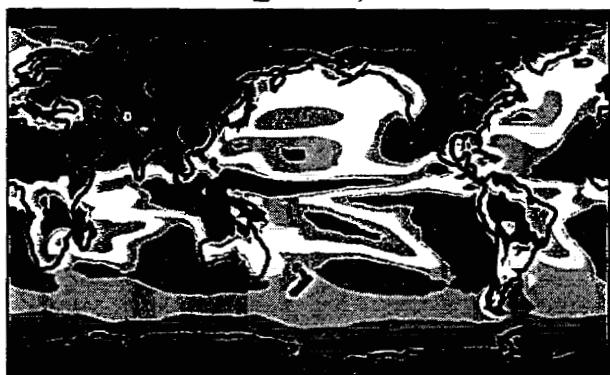
Observed (CPC, Xie-Arkin), DJF

Observed (CPC, Xie-Arkin), JJA



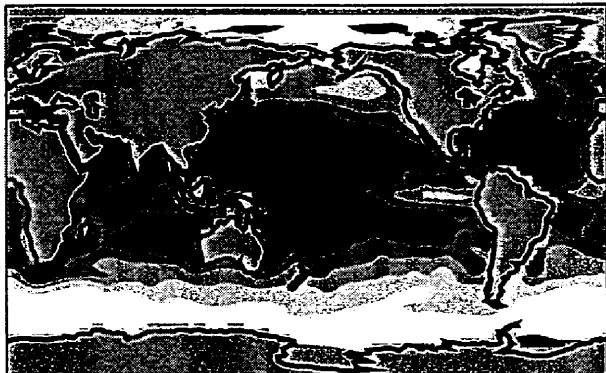
SLD\_AMIP2, DJF

SLD\_AMIP2, JJA

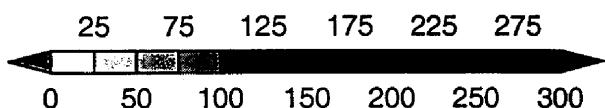


Heat flux latent surface ( $\text{W/m}^2$ )

Observed (COADS), DJF



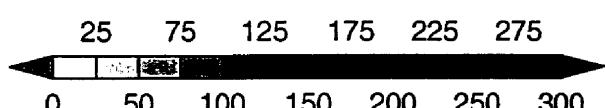
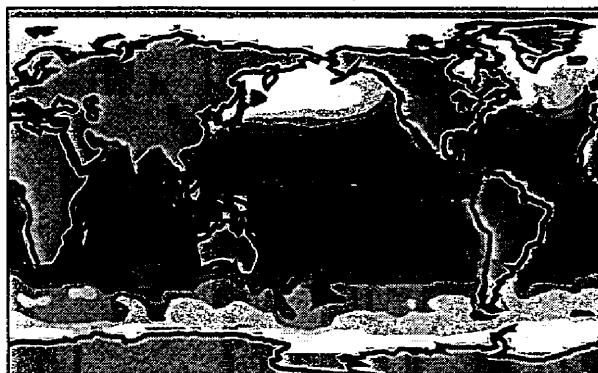
Observed (COADS), JJA



SLD\_AMIP2, DJF



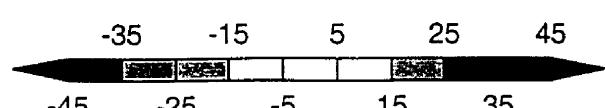
SLD\_AMIP2, JJA



SLD\_AMIP2 - Observed (COADS), DJF

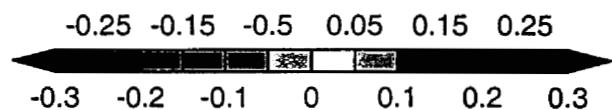
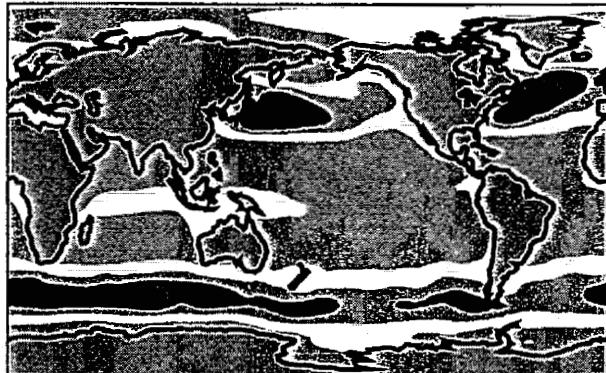


SLD\_AMIP2 - Observed (COADS), JJA

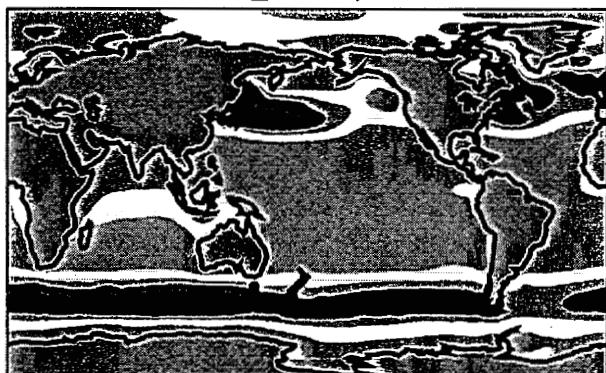


# SLD\_AMIP2

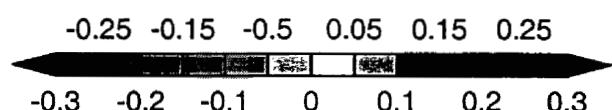
Eastward surface wind stress (positive for eastward wind) ( $\text{N/m}^2$ )  
UWMCOADS, DJF



SLD\_AMIP2, DJF



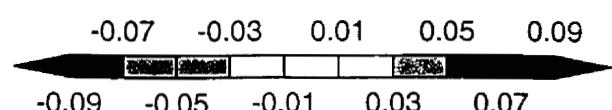
SLD\_AMIP2, JJA



SLD\_AMIP2 - UWMCOADS, DJF



SLD\_AMIP2 - UWMCOADS, JJA



# SLD\_AMIP2

LW radiation TOA (OLR) ( $\text{W/m}^2$ )

Observed (ERBE), DJF



Observed (ERBE), JJA



120 160 200 240 280 320

100 140 180 220 260 300 340

SLD\_AMIP2, DJF



SLD\_AMIP2, JJA



120 160 200 240 280 320

100 140 180 220 260 300 340

SLD\_AMIP2 - Observed (ERBE), DJF



SLD\_AMIP2 - Observed (ERBE), JJA



-35 -15 5 25 45

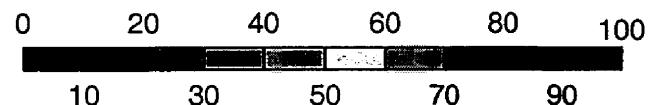
-45 -25 -5 15 35

Total Cloud Amount (%)

Observed (ISCCP), DJF



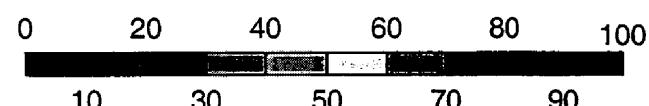
Observed (ISCCP), JJA



SLD\_AMIP2, DJF



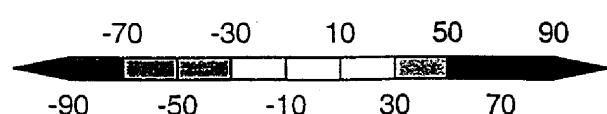
SLD\_AMIP2, JJA



SLD\_AMIP2 - Observed (ISCCP), DJF



SLD\_AMIP2 - Observed (ISCCP), JJA



# SLD\_AMIP2

Sea Level Pressure (hPa)

Observed (ECMWF Reanalysis), DJF



Observed (ECMWF Reanalysis), JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

SLD\_AMIP2, DJF



SLD\_AMIP2, JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

SLD\_AMIP2 - Observed (ECMWF Reanalysis), DJF SLD\_AMIP2 - Observed (ECMWF Reanalysis), JJA

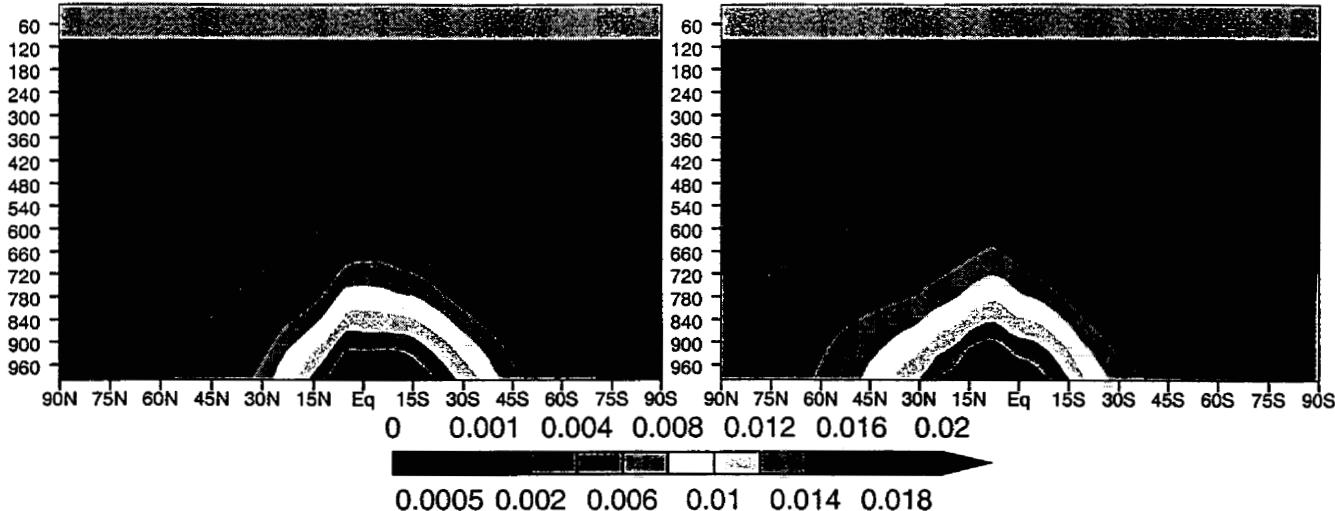


-7 -3 1 5 9

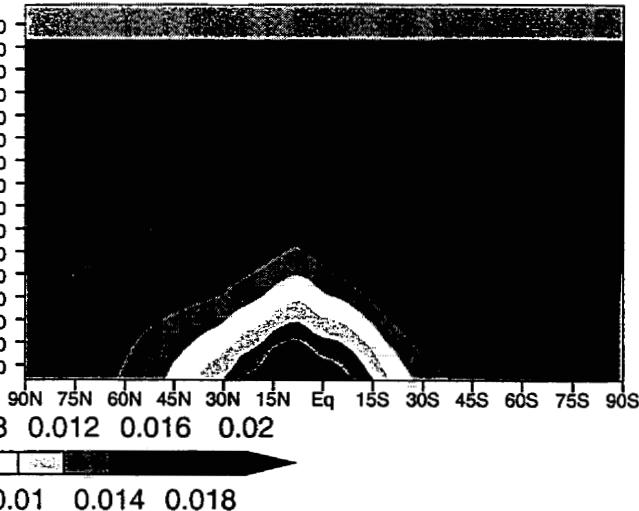
-9 -5 -1 3 7

Specific humidity

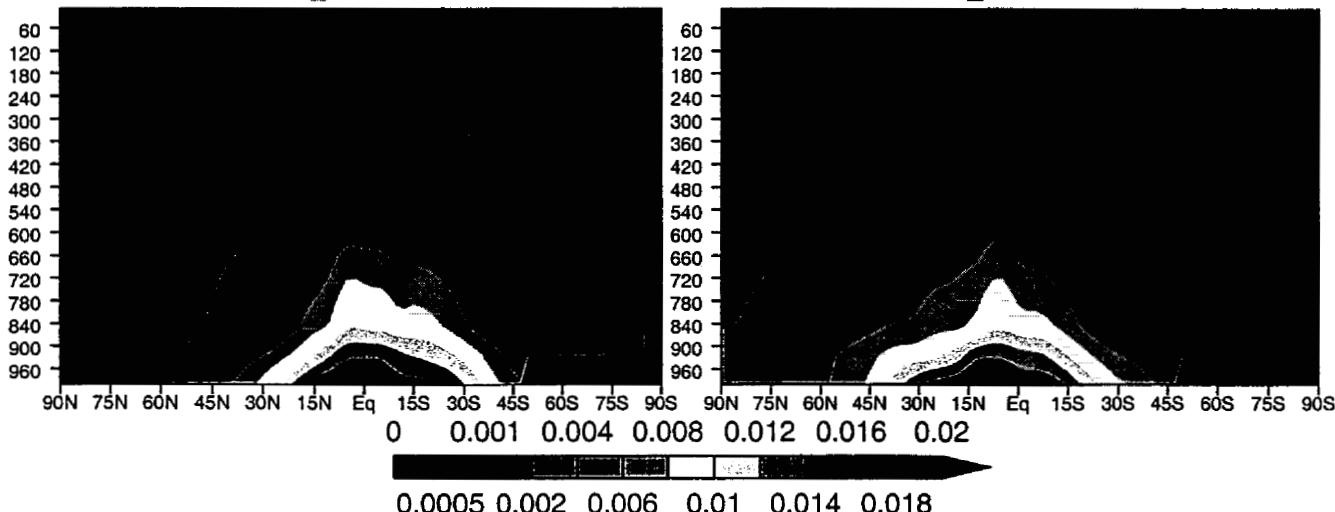
ECMWF reanalysis DJF



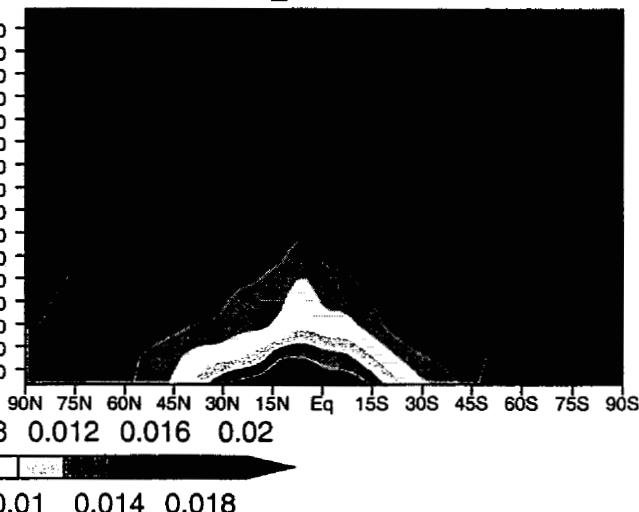
ECMWF reanalysis JJA



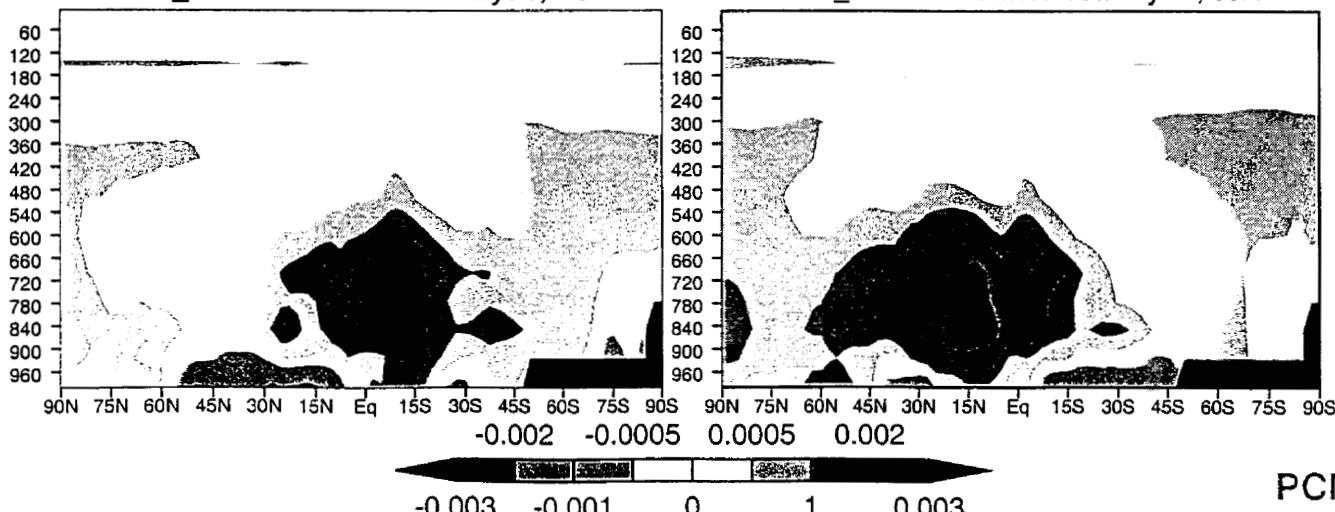
SLD\_AMIP2 DJF



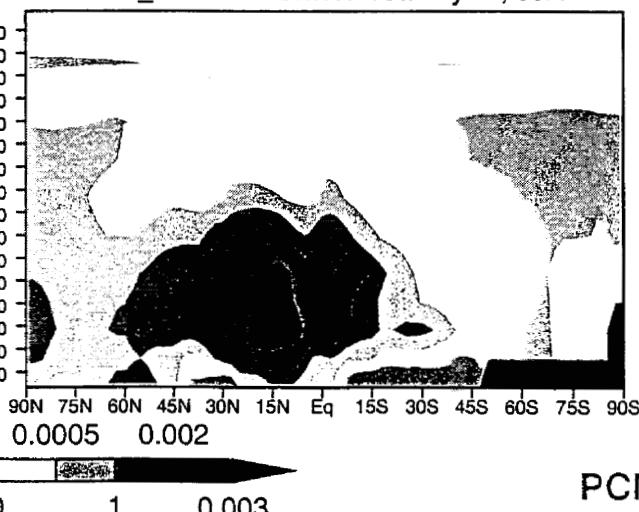
SLD\_AMIP2 JJA

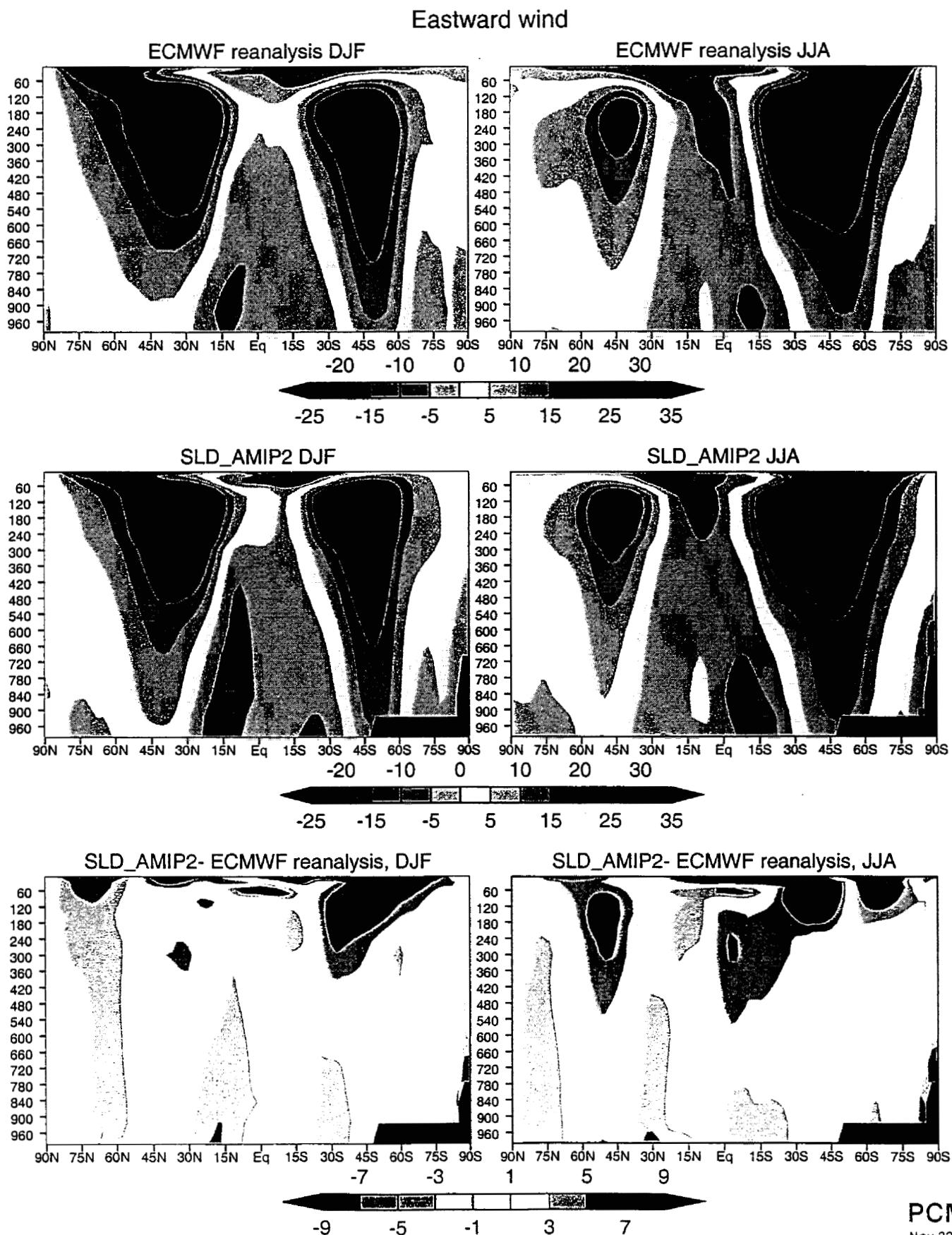


SLD\_AMIP2- ECMWF reanalysis, DJF



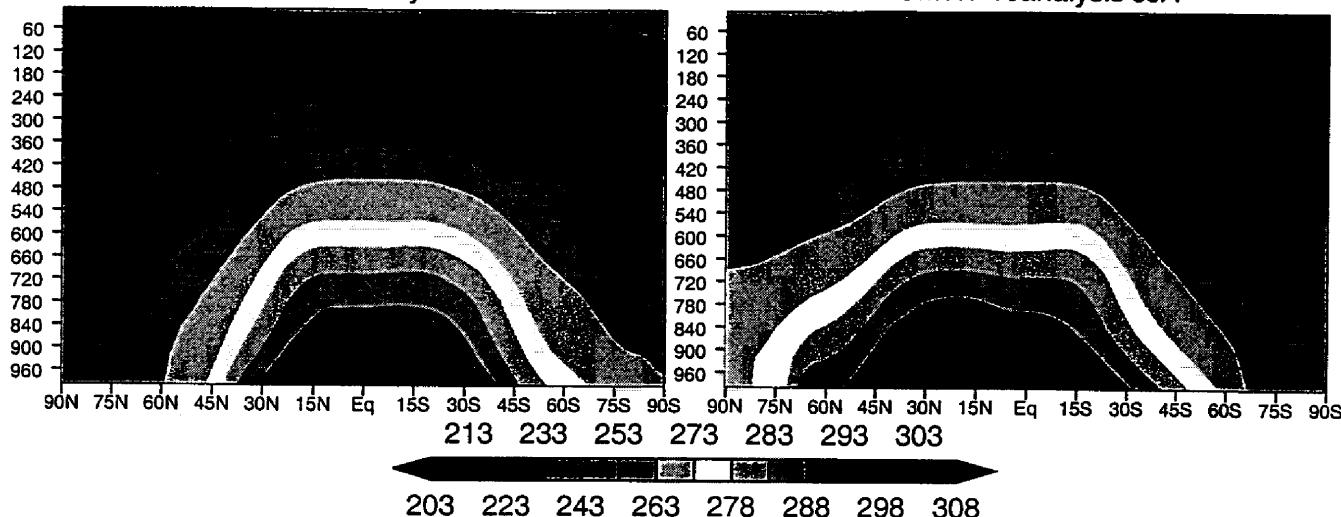
SLD\_AMIP2- ECMWF reanalysis, JJA



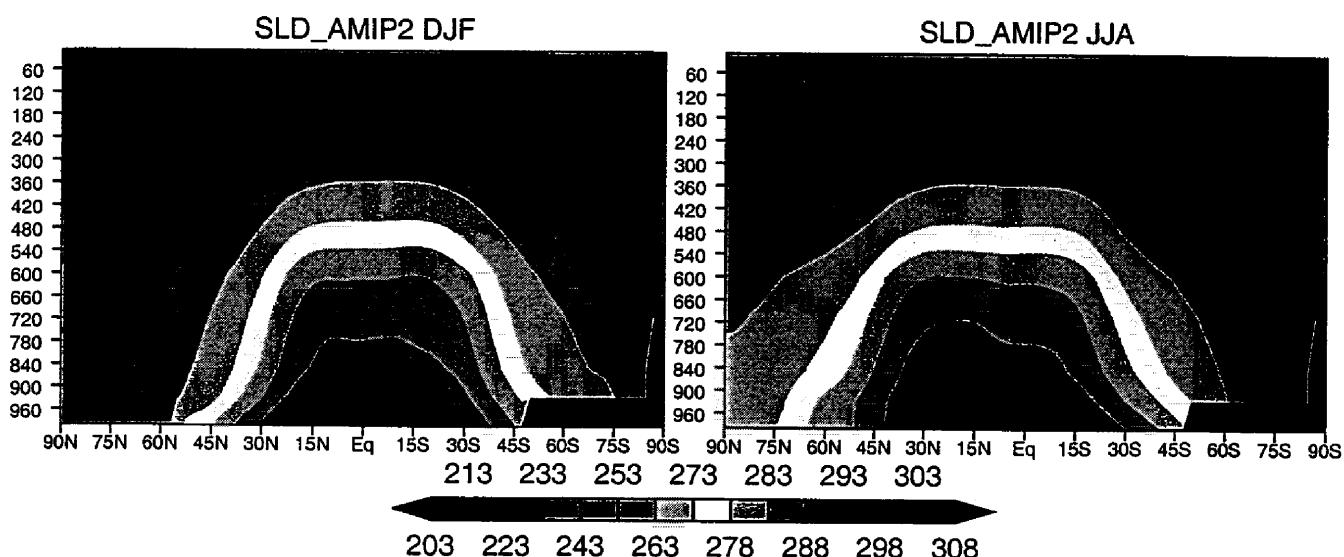


Air Temperature

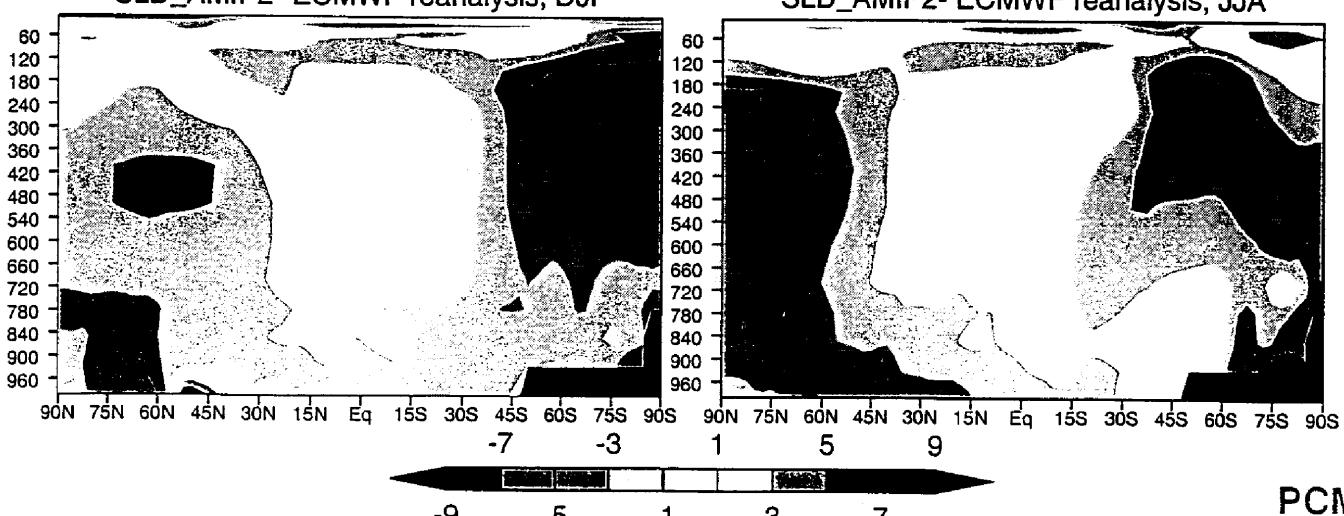
ECMWF reanalysis DJF



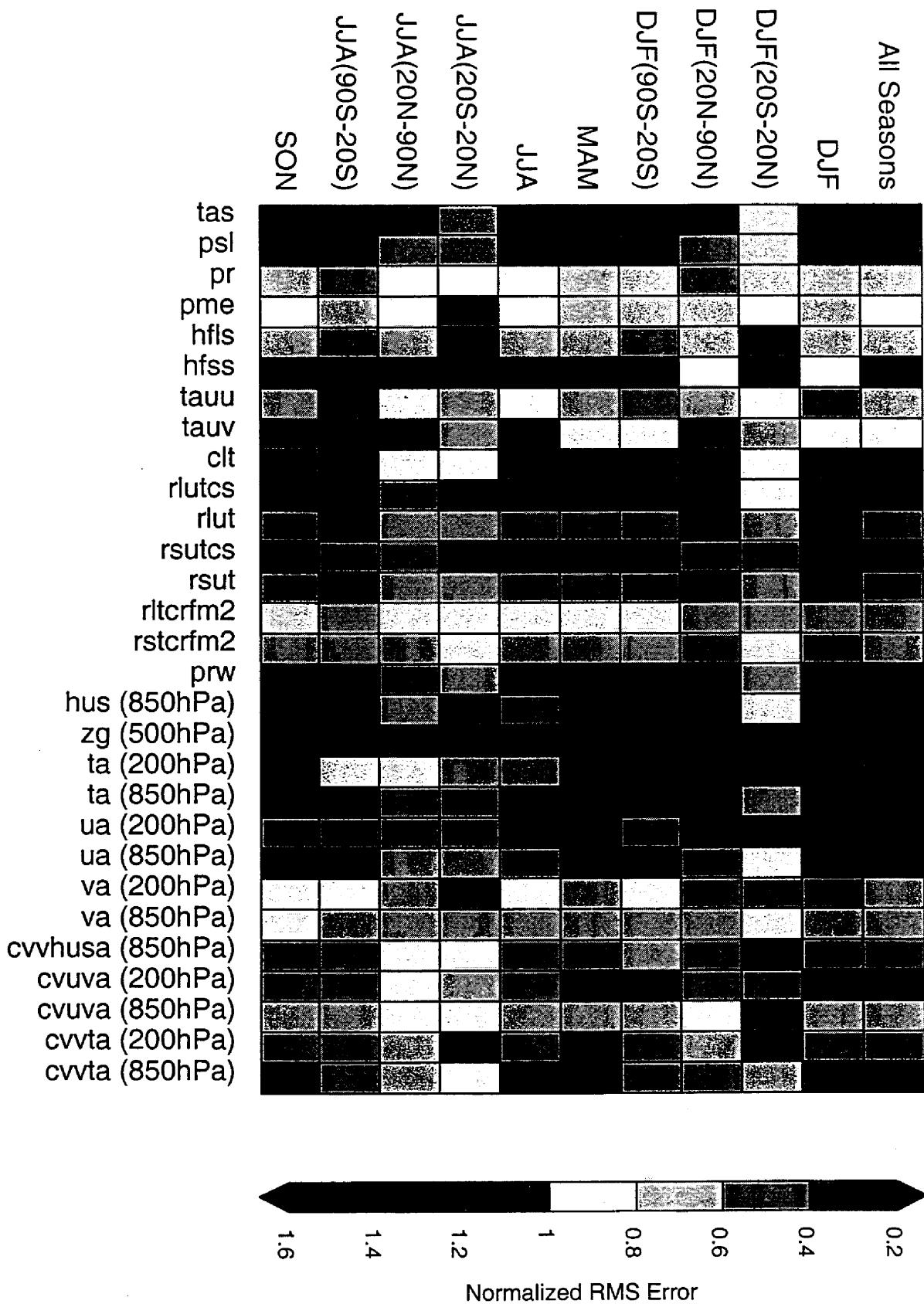
ECMWF reanalysis JJA



SLD\_AMIP2- ECMWF reanalysis, DJF



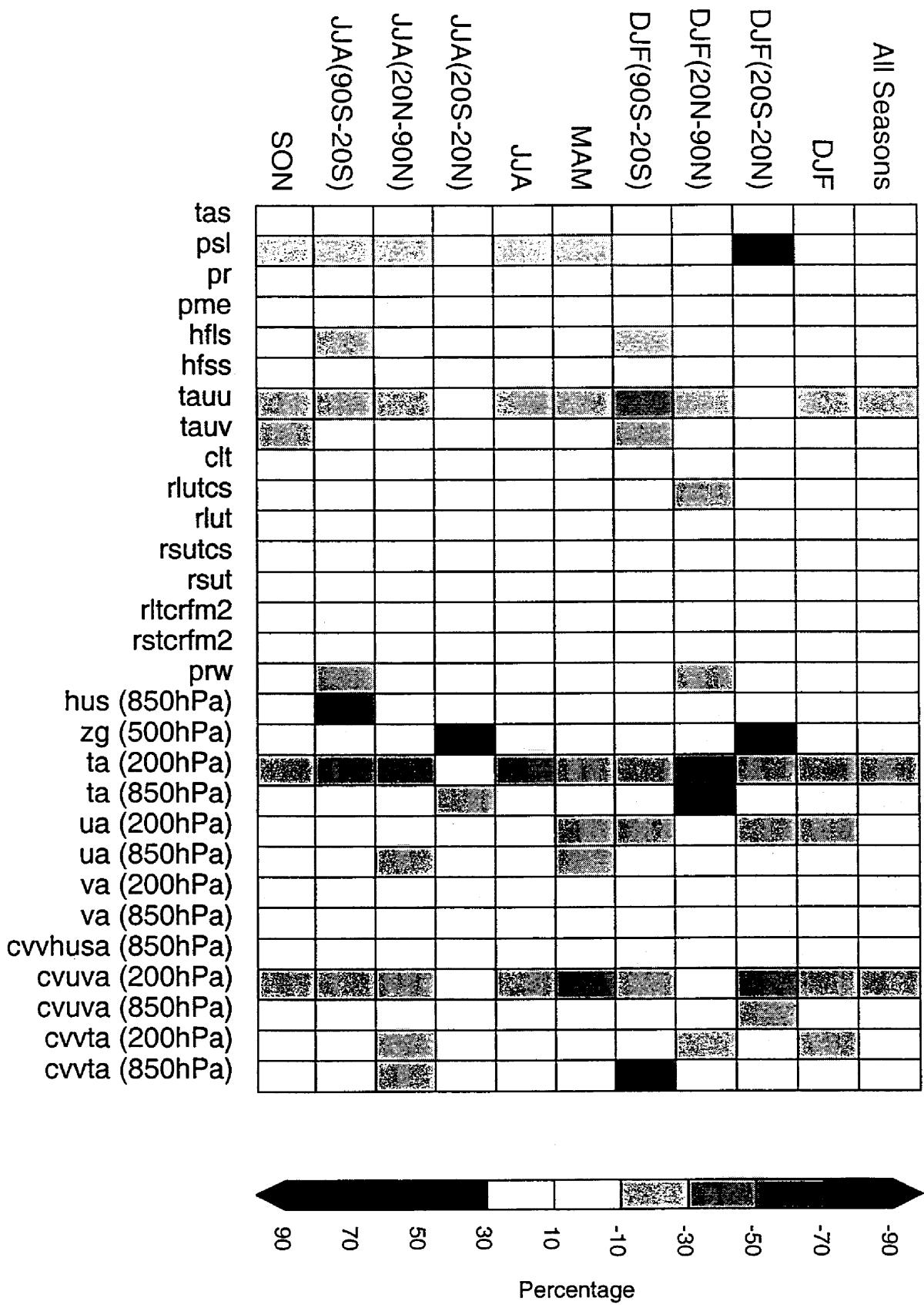
## SLDAMIP Normalized Total Error



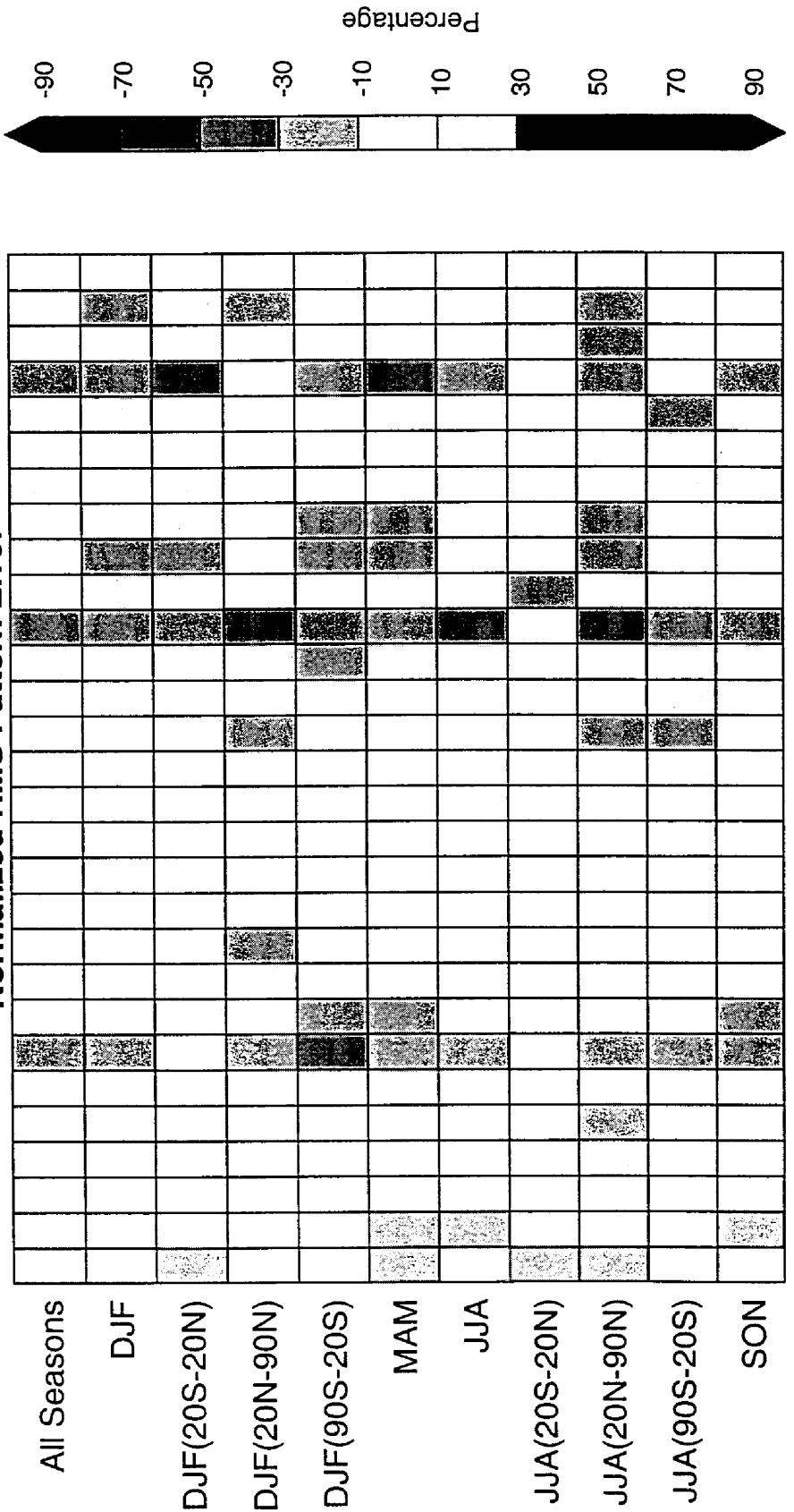
# SLD\_AMIP: Percentage Difference from CCM3.9.11 AMIP2

Normalized Total Error

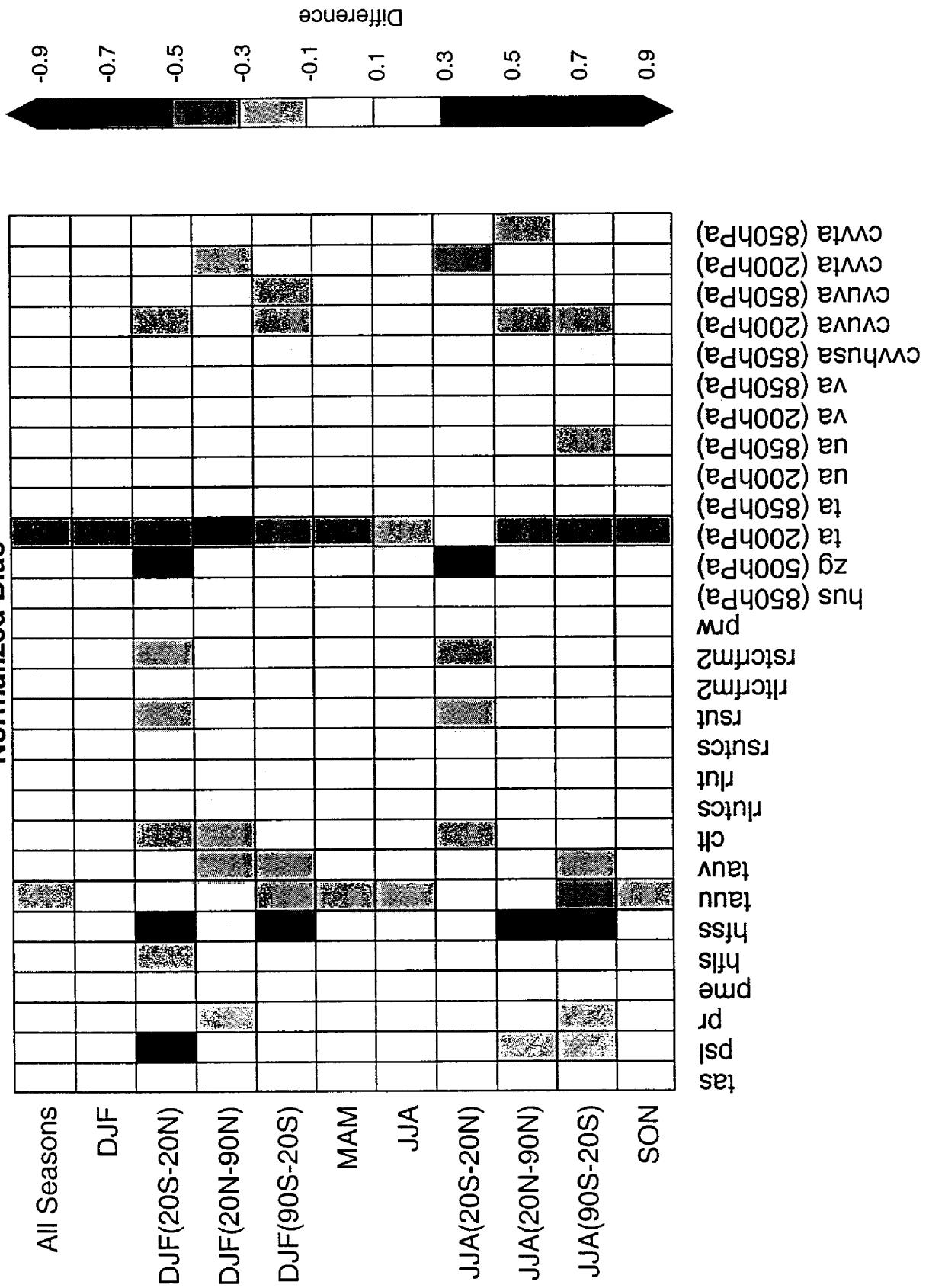
PCMDI  
Nov 30, 2000



## SLD\_AMIP: Percentage Difference from CCM3.9.11 AMIP2 Normalized RMS Pattern Error



## SLD\_AMIP: Absolute Difference from CCM3.9.11 AMIP2

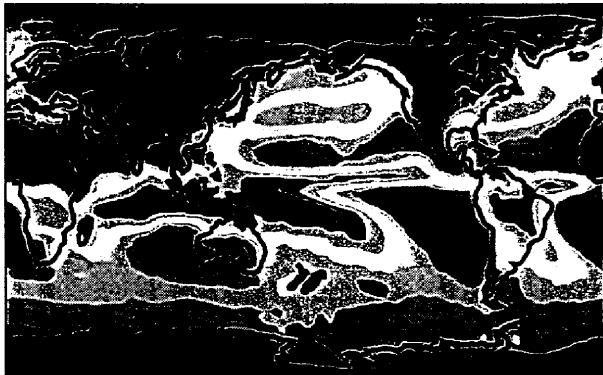


# **LR\_AMIP2**

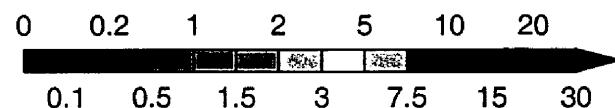
- CCM 3.10 with Lin-Rood dynamics
- $2^{\circ} \times 2.5^{\circ}$ , 30 levels
- AMIP2 run
- Contact: Sharon Nebuda, NASA-GSFC  
Data Assimilation Office,  
[nebuda@dao.gsfc.nasa.gov](mailto:nebuda@dao.gsfc.nasa.gov)

Total precipitation rate (mm/day)

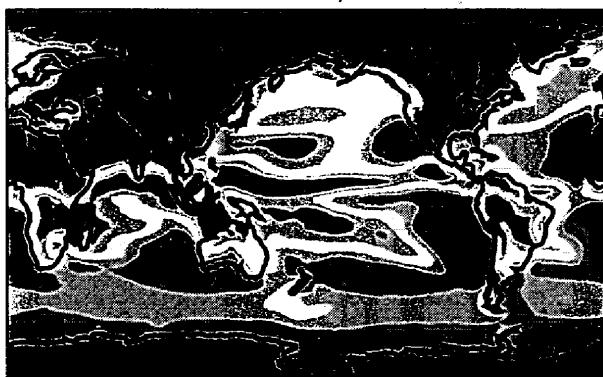
Observed (CPC, Xie-Arkin), DJF



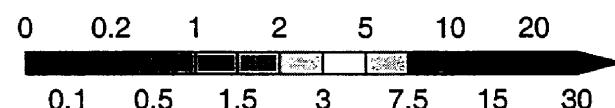
Observed (CPC, Xie-Arkin), JJA



LRAMIP2, DJF



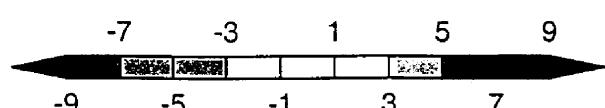
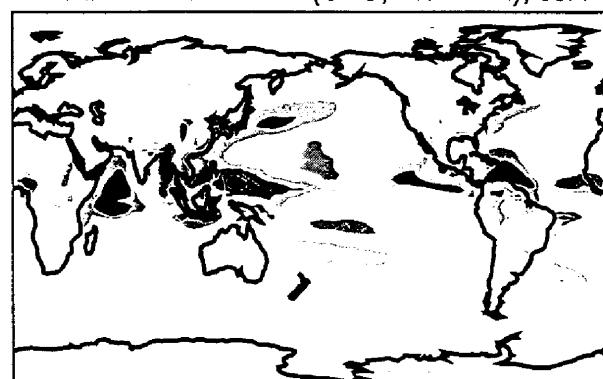
LRAMIP2, JJA



LRAMIP2 - Observed (CPC, Xie-Arkin), DJF



LRAMIP2 - Observed (CPC, Xie-Arkin), JJA

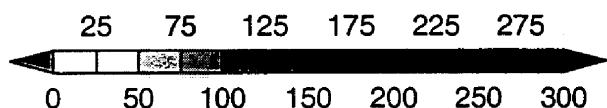
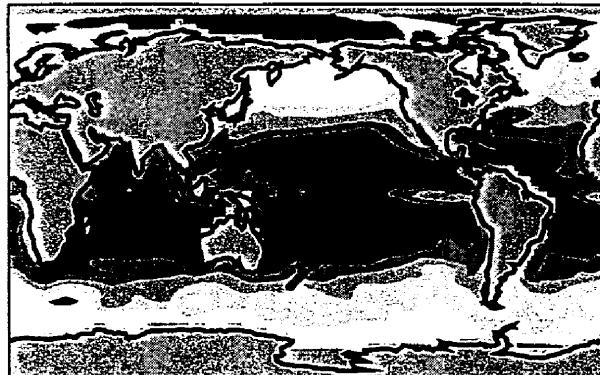


Heat flux latent surface ( $\text{W/m}^2$ )

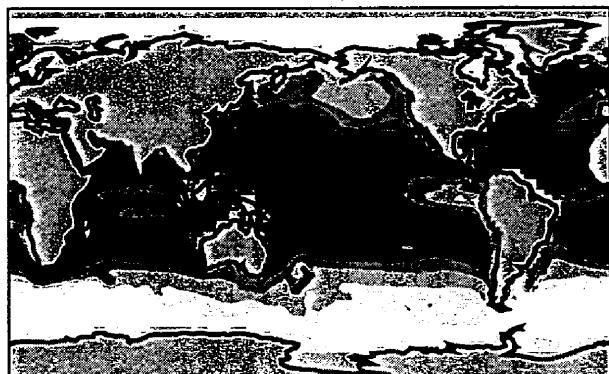
Observed (COADS), DJF



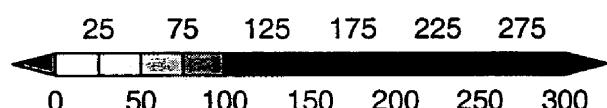
Observed (COADS), JJA



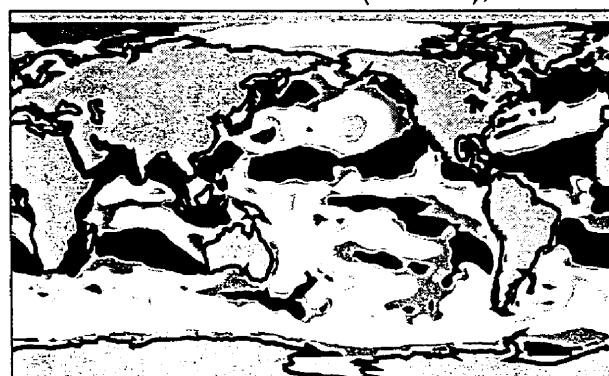
LRAMIP2, DJF



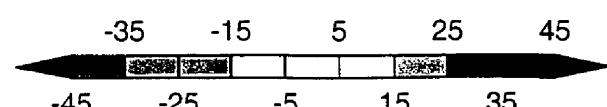
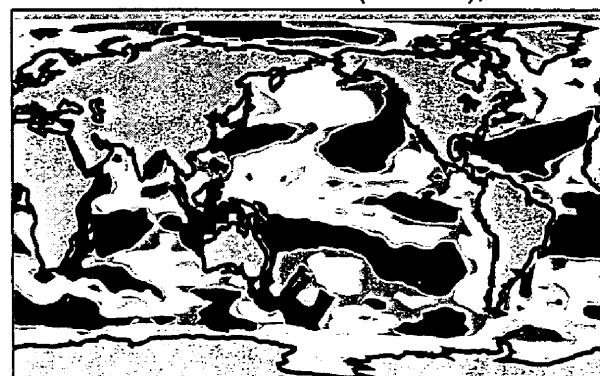
LRAMIP2, JJA



LRAMIP2 - Observed (COADS), DJF



LRAMIP2 - Observed (COADS), JJA

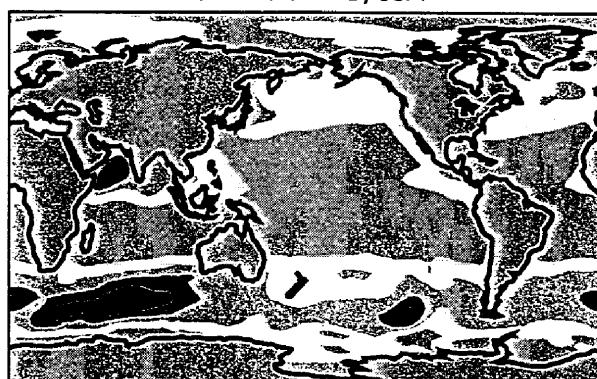


Eastward surface wind stress (positive for eastward wind) ( $\text{N/m}^2$ )

UWMCOADS, DJF



UWMCOADS, JJA



-0.25 -0.15 -0.5 0.05 0.15 0.25

-0.3 -0.2 -0.1 0 0.1 0.2 0.3

LRAMIP2, DJF



LRAMIP2, JJA



-0.25 -0.15 -0.5 0.05 0.15 0.25

-0.3 -0.2 -0.1 0 0.1 0.2 0.3

LRAMIP2 - UWMCOADS, DJF



LRAMIP2 - UWMCOADS, JJA



-0.07 -0.03 0.01 0.05 0.09

-0.09 -0.05 -0.01 0.03 0.07

LW radiation TOA (OLR) (W/m<sup>2</sup>)

Observed (ERBE), DJF



Observed (ERBE), JJA

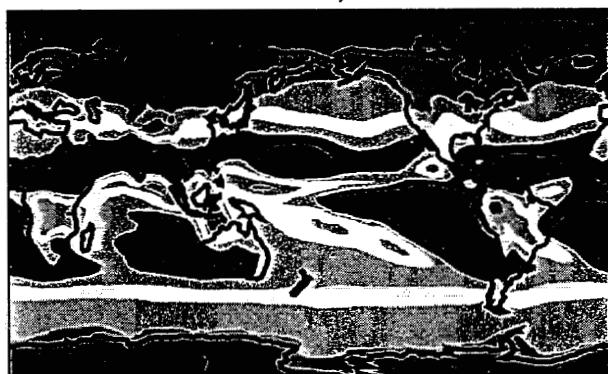


120 160 200

240 280 320

100 140 180 220 260 300 340

LRAMIP2, DJF



LRAMIP2, JJA



120 160 200

240 280 320

100 140 180 220 260 300 340

LRAMIP2 - Observed (ERBE), DJF



LRAMIP2 - Observed (ERBE), JJA



-35 -15 5 25 45

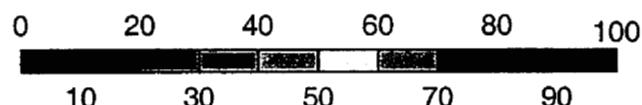
-45 -25 -5 15 35

Total Cloud Amount (%)

Observed (ISCCP), DJF



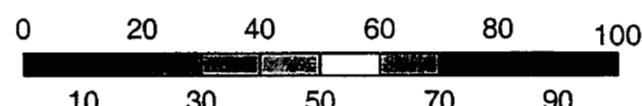
Observed (ISCCP), JJA



LRAMIP2, DJF



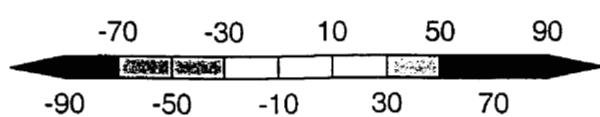
LRAMIP2, JJA



LRAMIP2 - Observed (ISCCP), DJF



LRAMIP2 - Observed (ISCCP), JJA



**Sea Level Pressure (hPa)**

Observed (ECMWF Reanalysis), DJF



Observed (ECMWF Reanalysis), JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

LRAMIP2, DJF



LRAMIP2, JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

LRAMIP2 - Observed (ECMWF Reanalysis), DJF



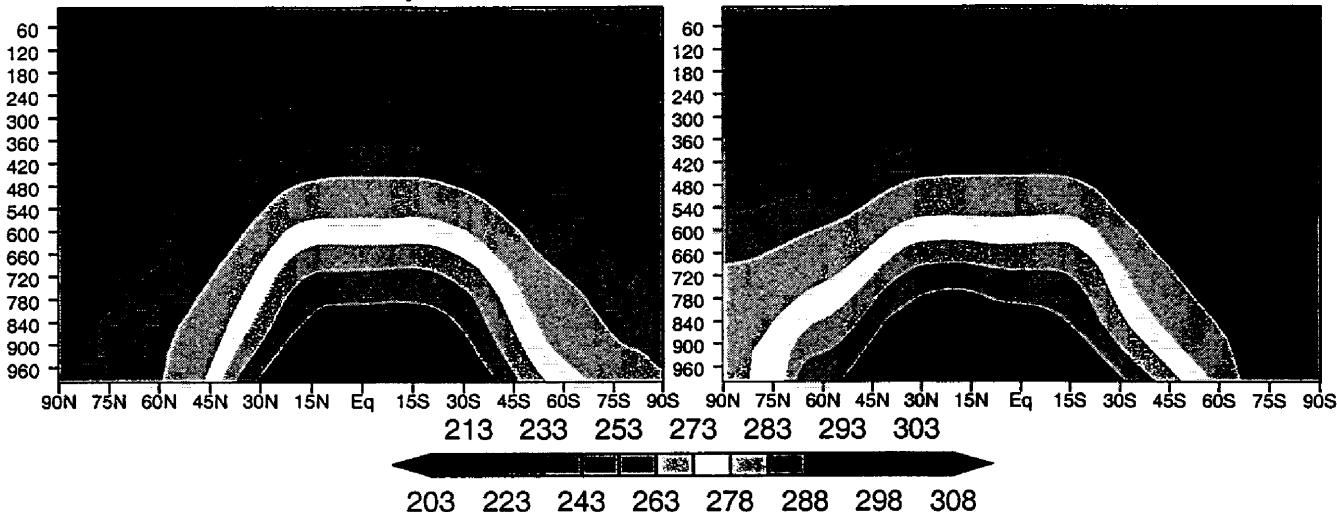
LRAMIP2 - Observed (ECMWF Reanalysis), JJA



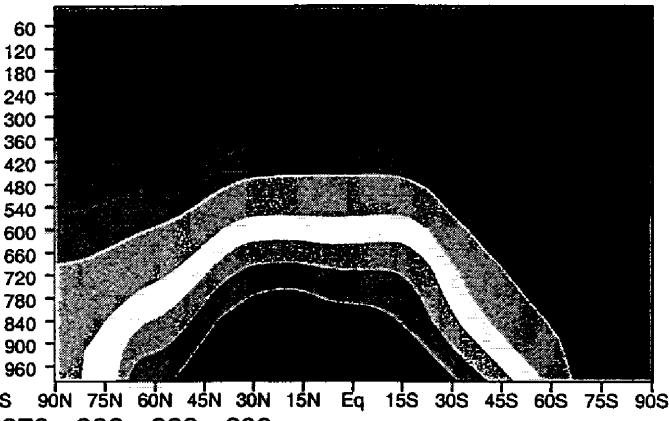
-9 -7 -5 -3 -1 1 3 5 7

Air Temperature

ECMWF reanalysis DJF

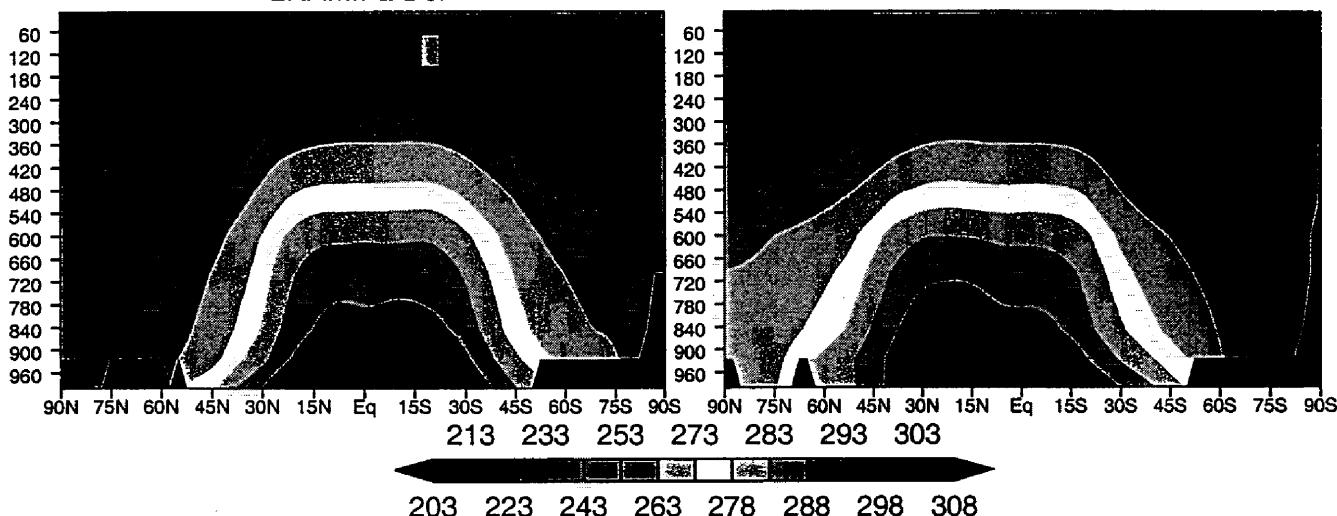


ECMWF reanalysis JJA



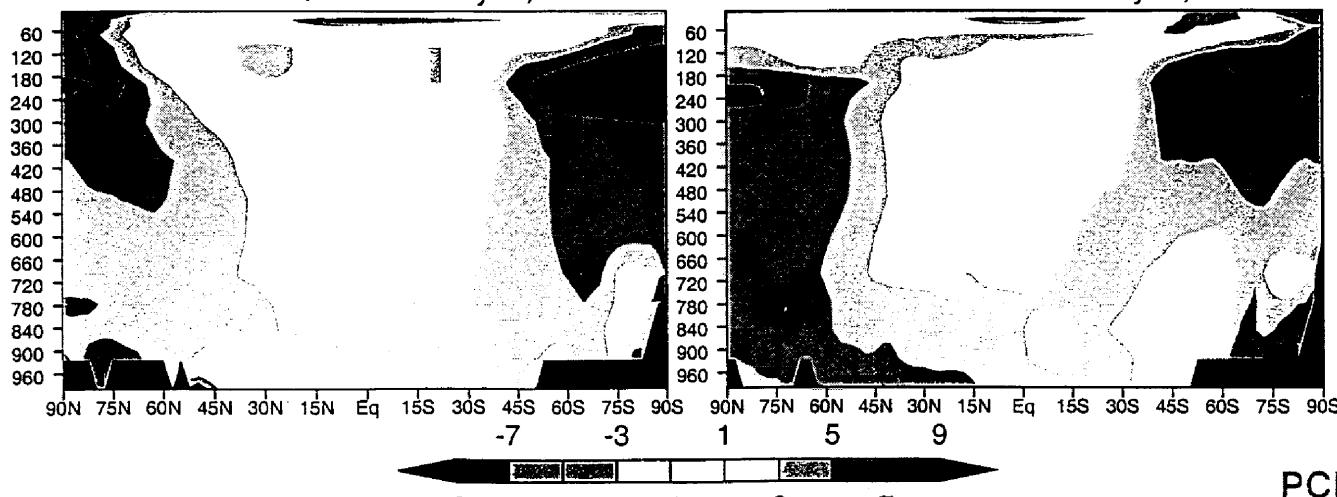
LRAMIP2 DJF

LRAMIP2 JJA

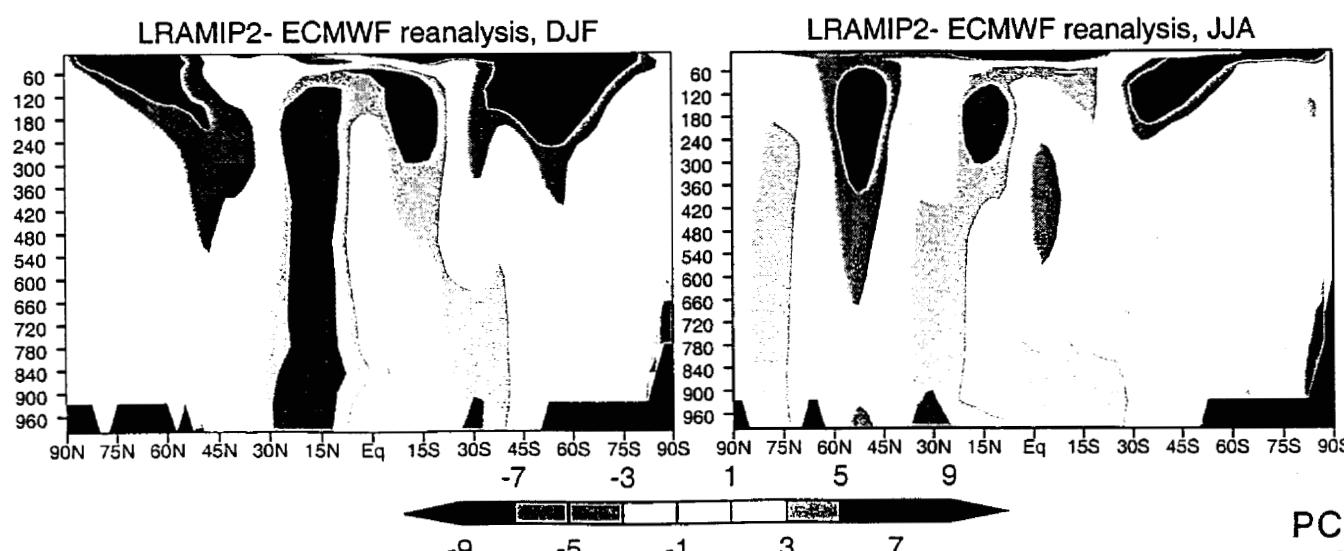
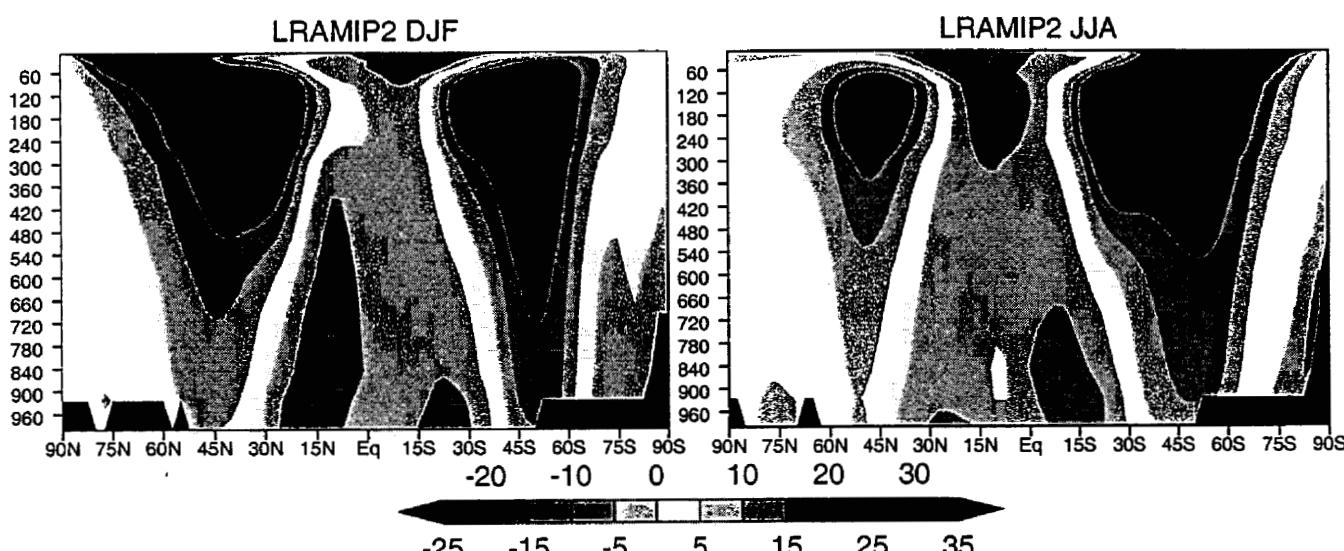
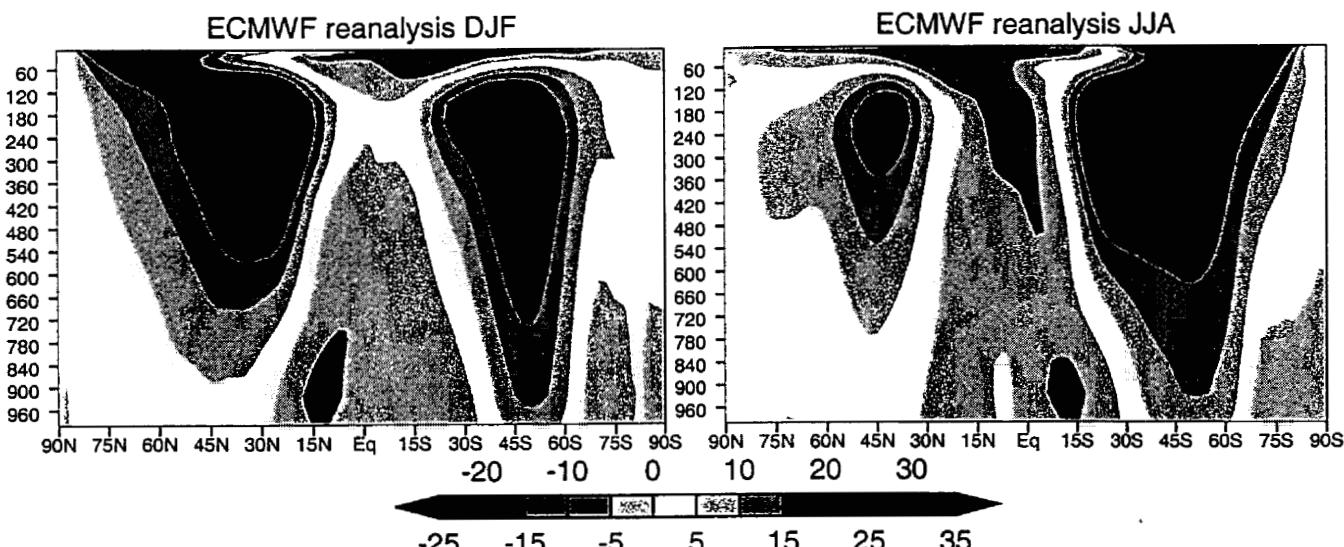


LRAMIP2- ECMWF reanalysis, DJF

LRAMIP2- ECMWF reanalysis, JJA

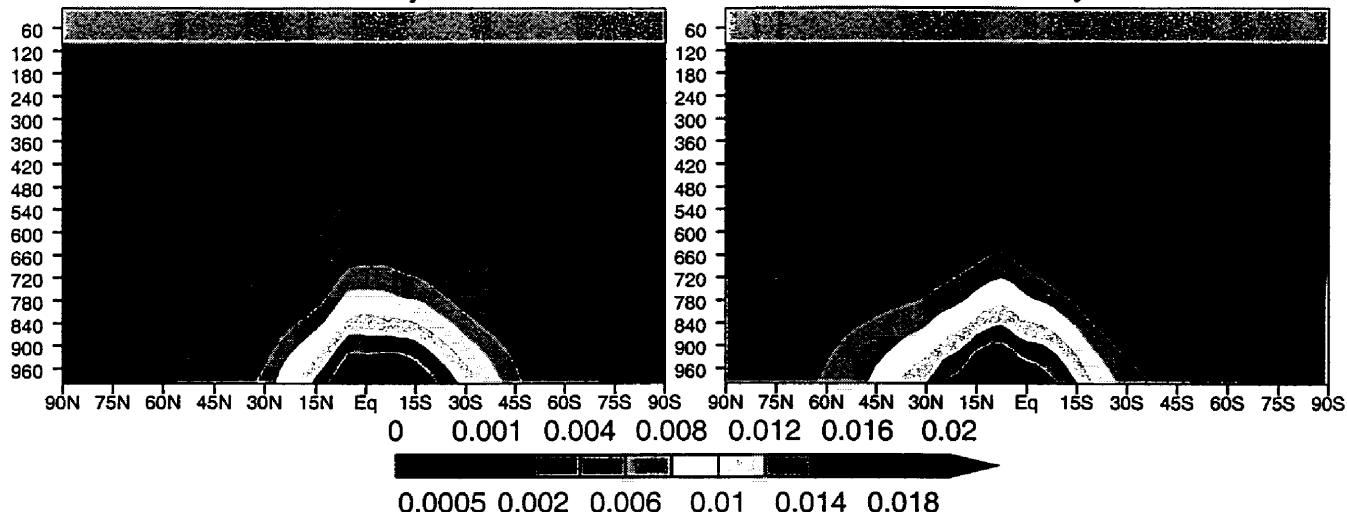


Eastward wind

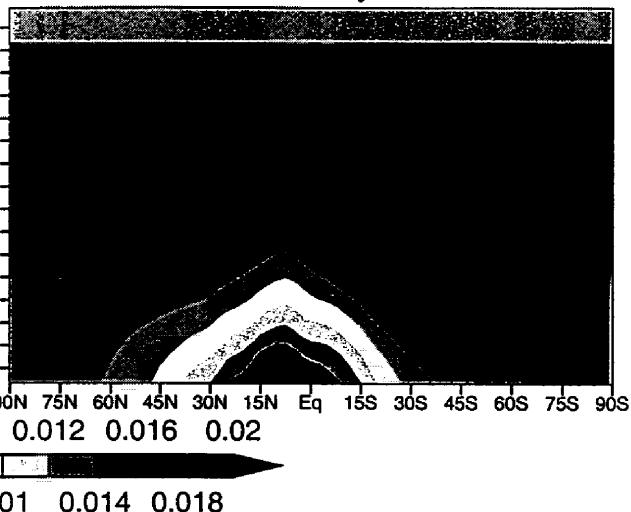


Specific humidity

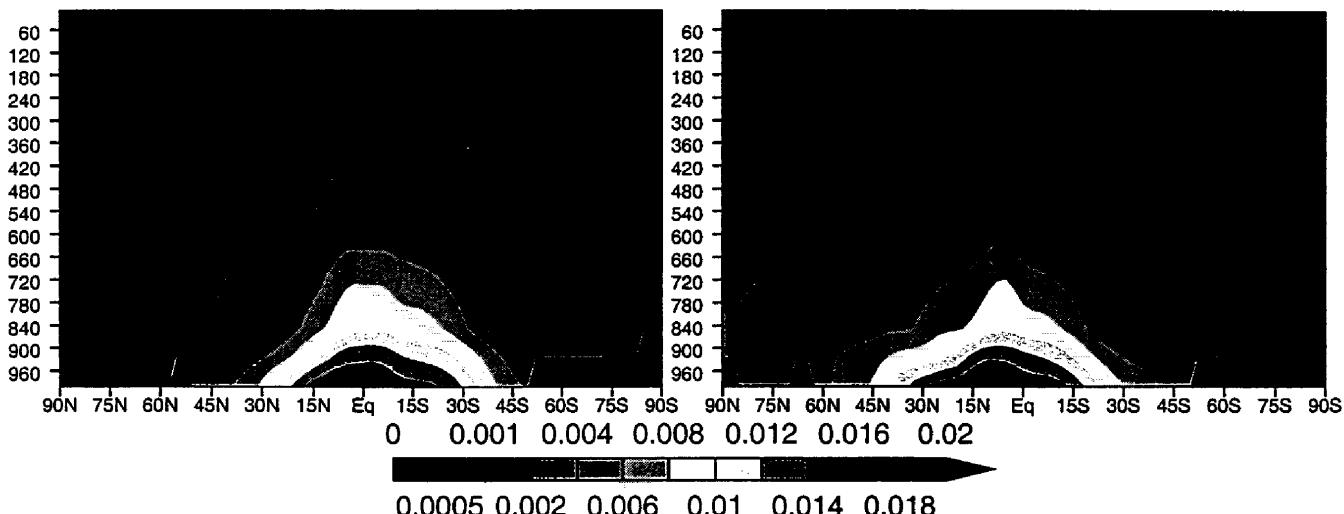
ECMWF reanalysis DJF



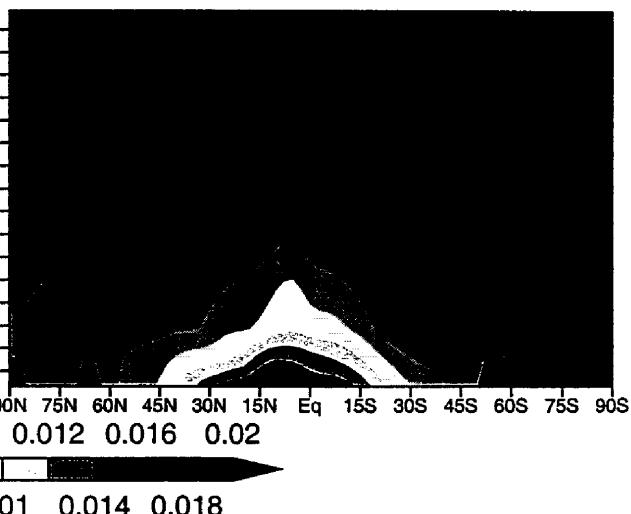
ECMWF reanalysis JJA



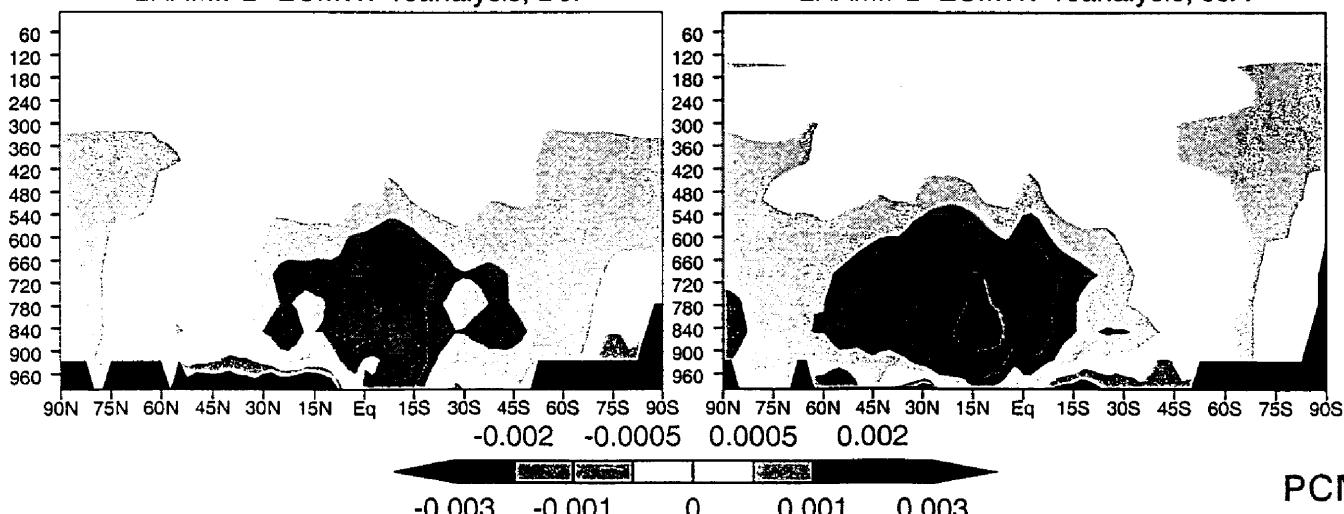
LRAMIP2 DJF



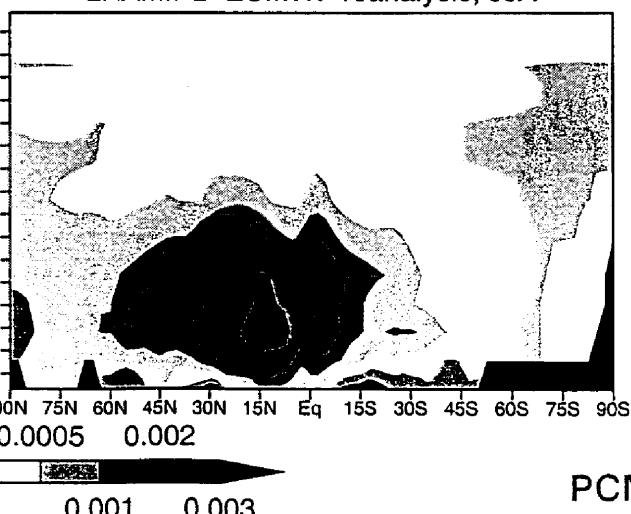
LRAMIP2 JJA



LRAMIP2- ECMWF reanalysis, DJF



LRAMIP2- ECMWF reanalysis, JJA



Sea Level Pressure (hPa)

Observed (ECMWF Reanalysis), DJF



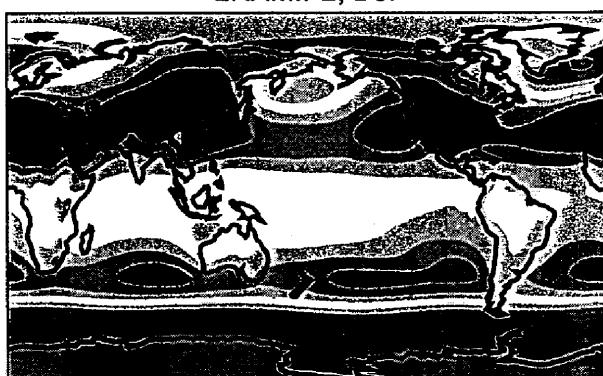
Observed (ECMWF Reanalysis), JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

LRAMIP2, DJF



LRAMIP2, JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

LRAMIP2 - Observed (ECMWF Reanalysis), DJF



LRAMIP2 - Observed (ECMWF Reanalysis), JJA

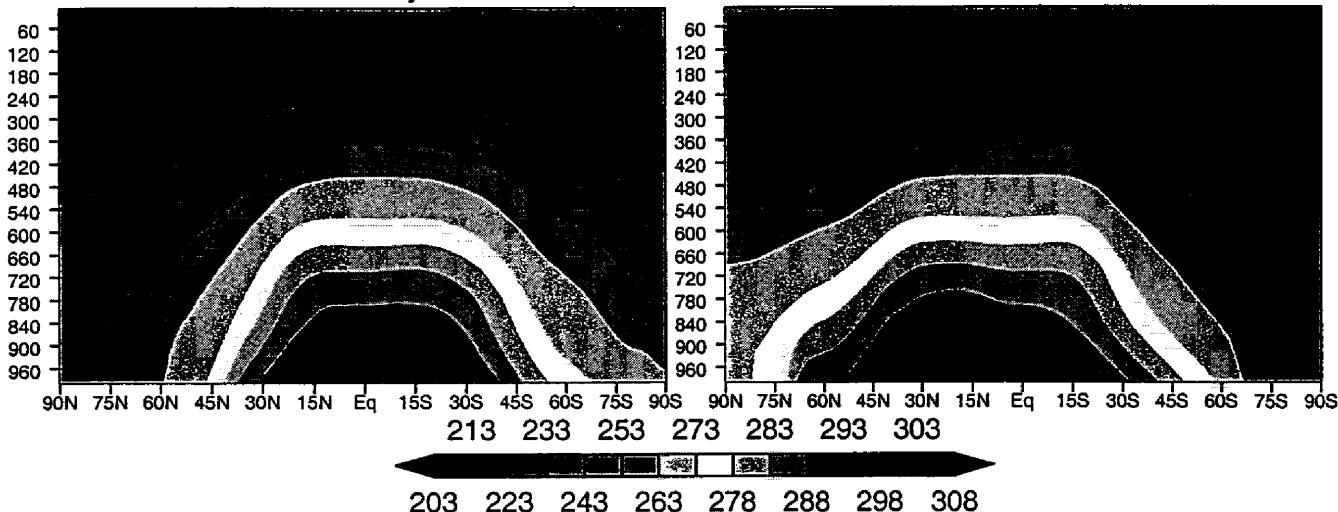


-7 -3 1 5 9

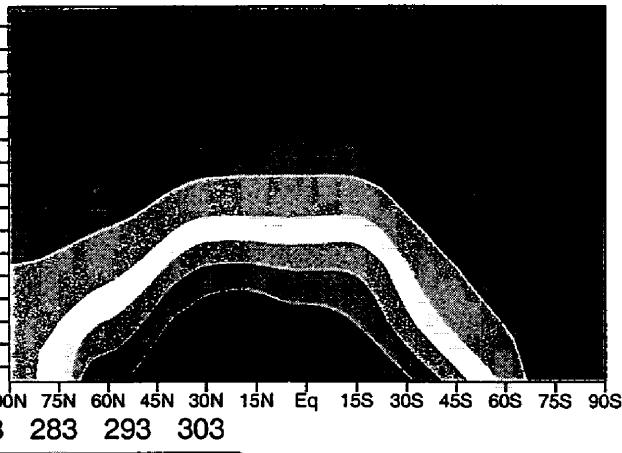
-9 -5 -1 3 7

Air Temperature

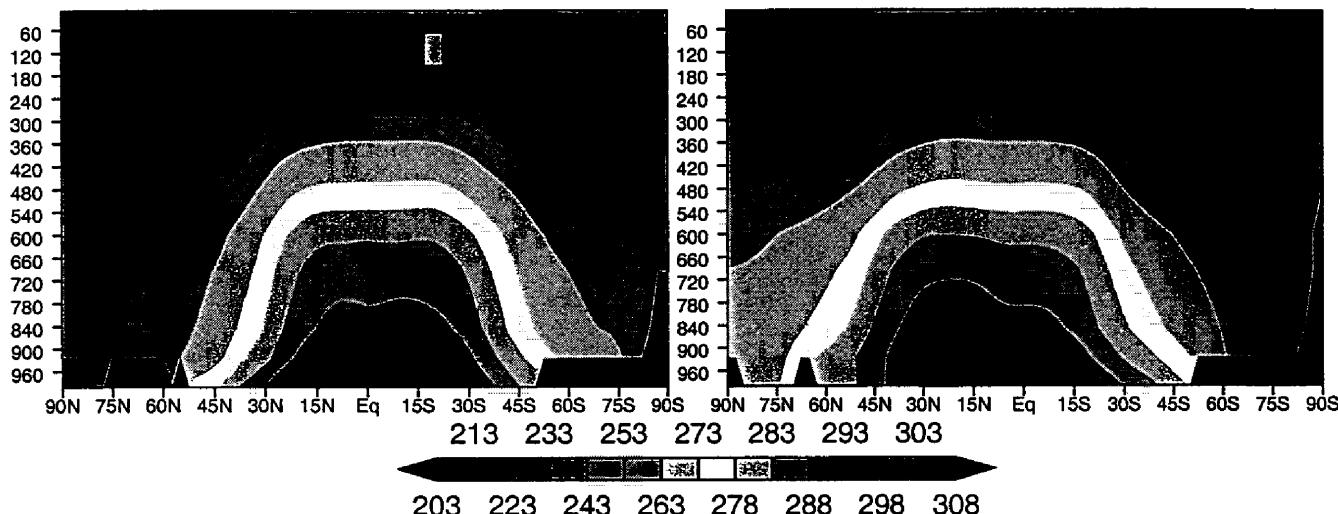
ECMWF reanalysis DJF



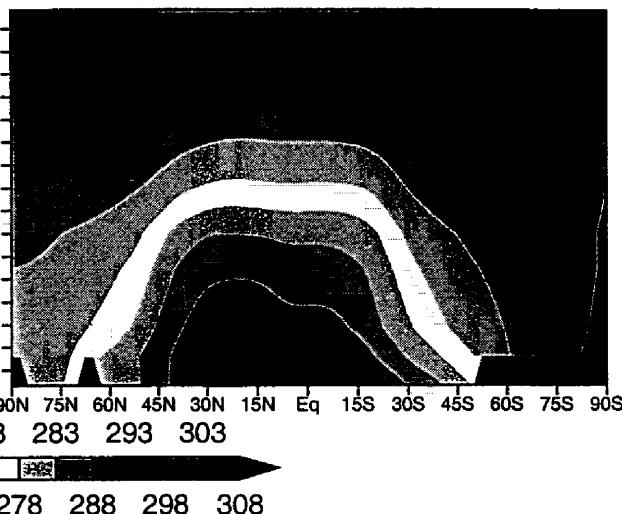
ECMWF reanalysis JJA



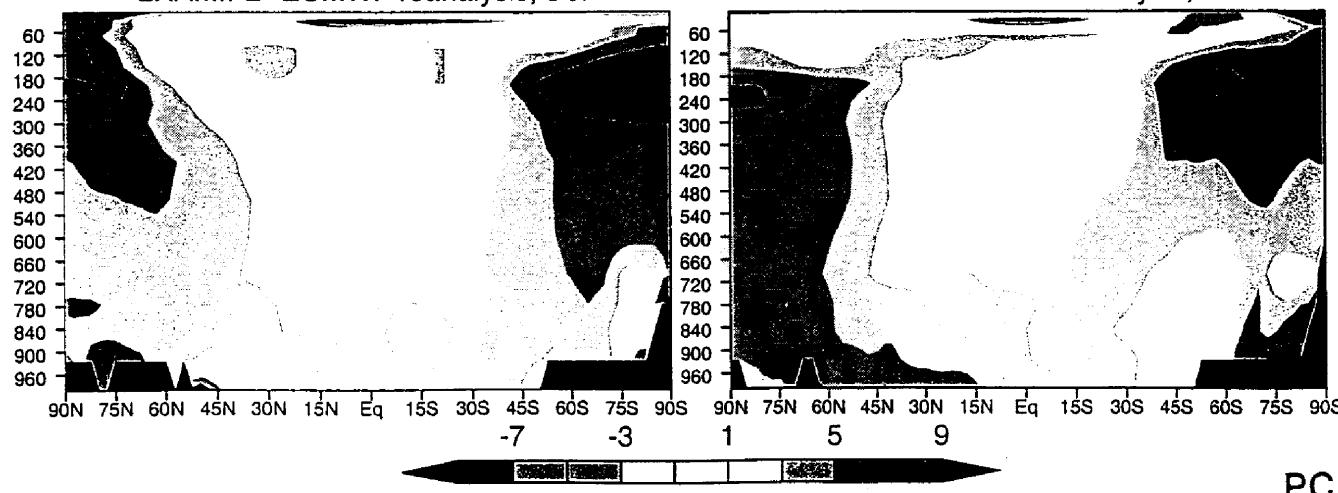
LRAMIP2 DJF



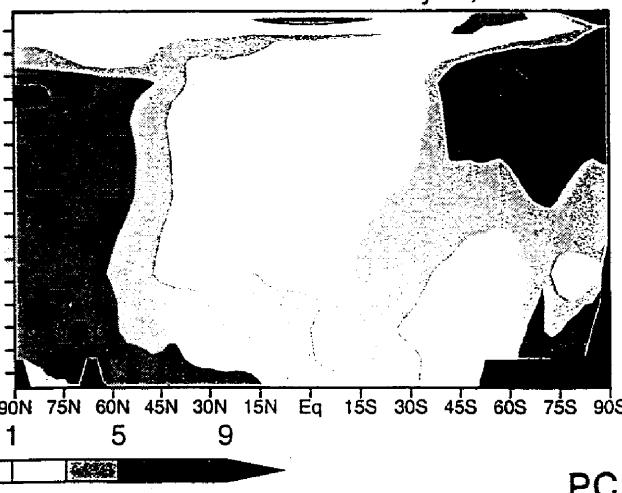
LRAMIP2 JJA



LRAMIP2- ECMWF reanalysis, DJF

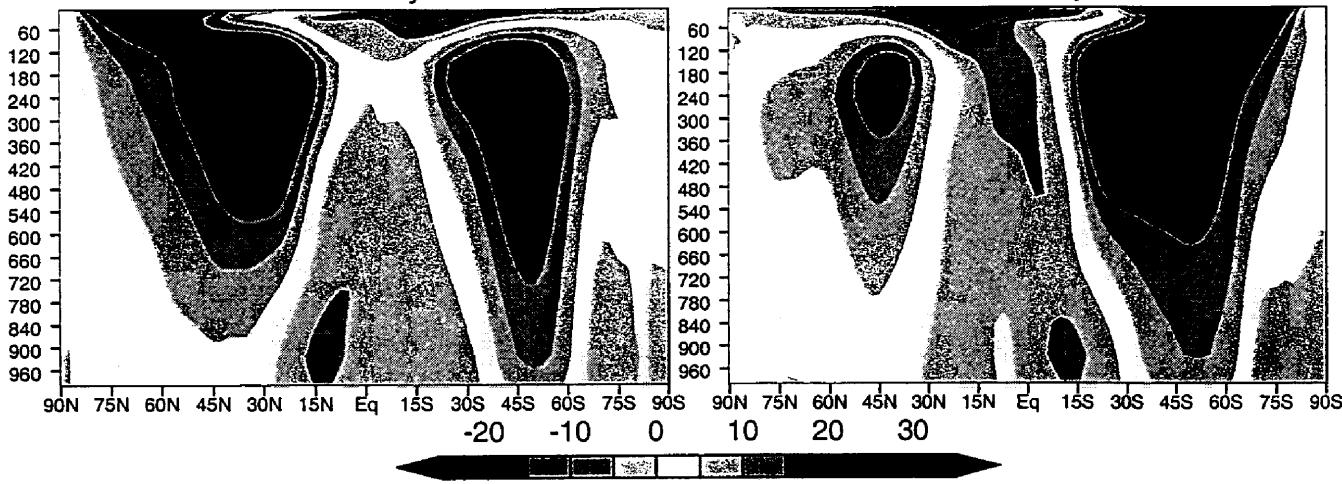


LRAMIP2- ECMWF reanalysis, JJA

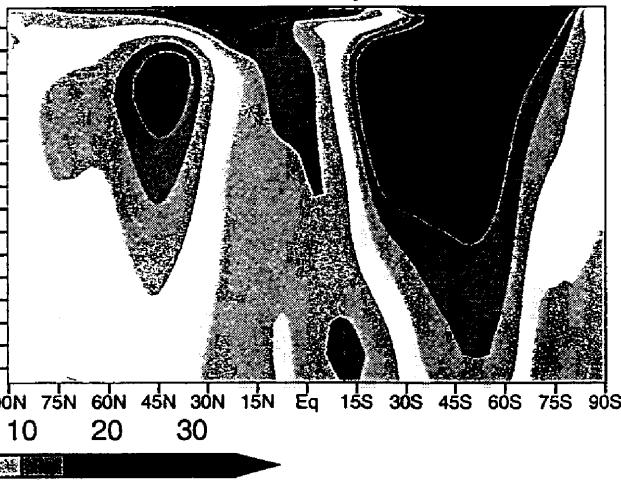


Eastward wind

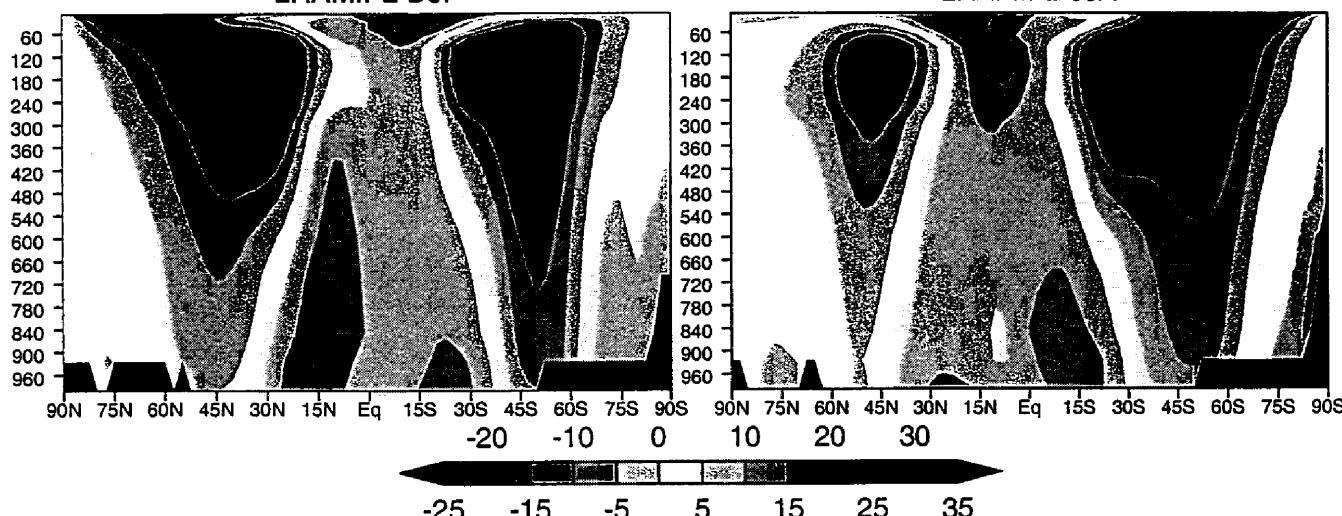
ECMWF reanalysis DJF



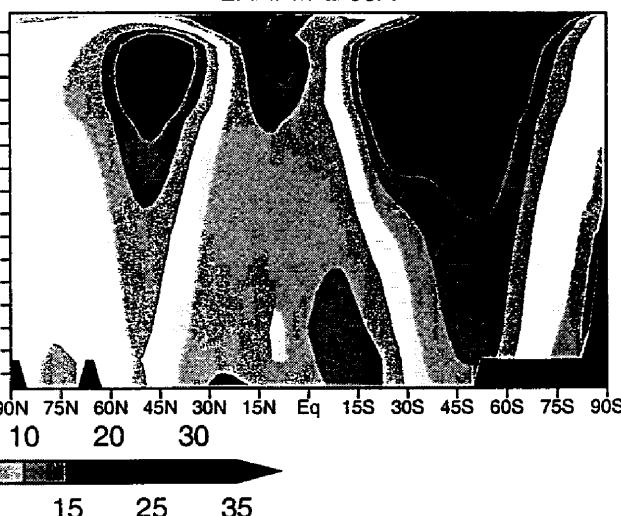
ECMWF reanalysis JJA



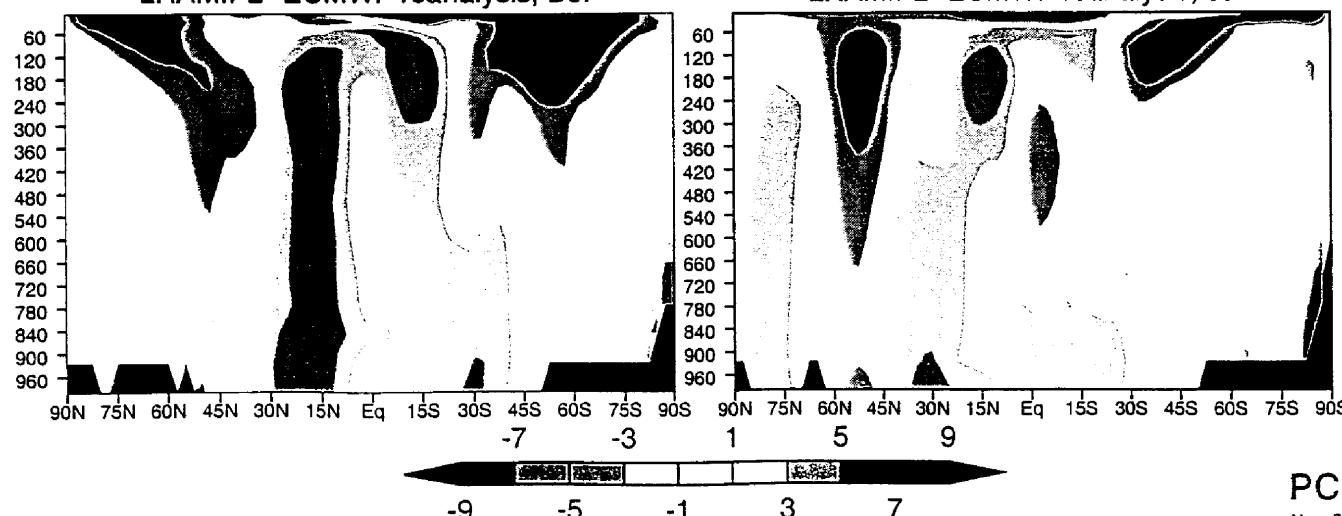
LRAMIP2 DJF



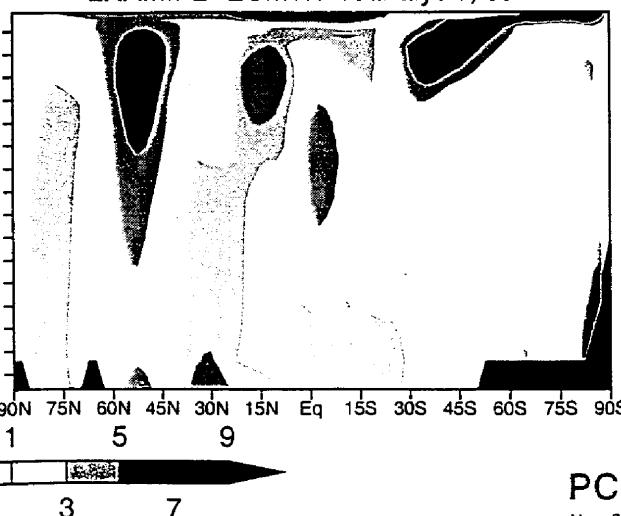
LRAMIP2 JJA



LRAMIP2- ECMWF reanalysis, DJF

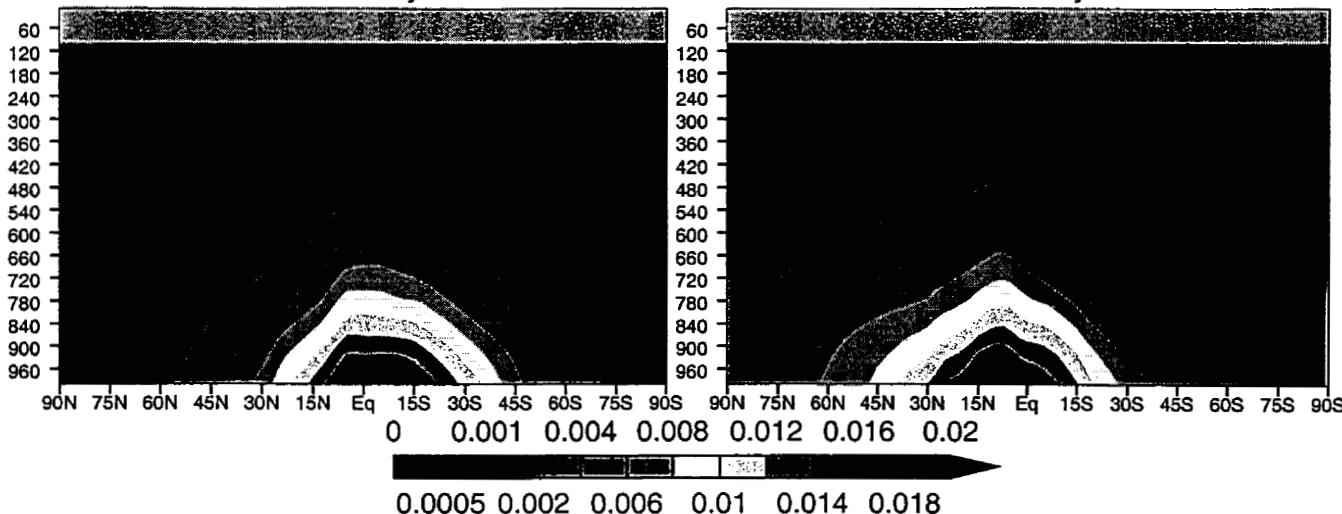


LRAMIP2- ECMWF reanalysis, JJA

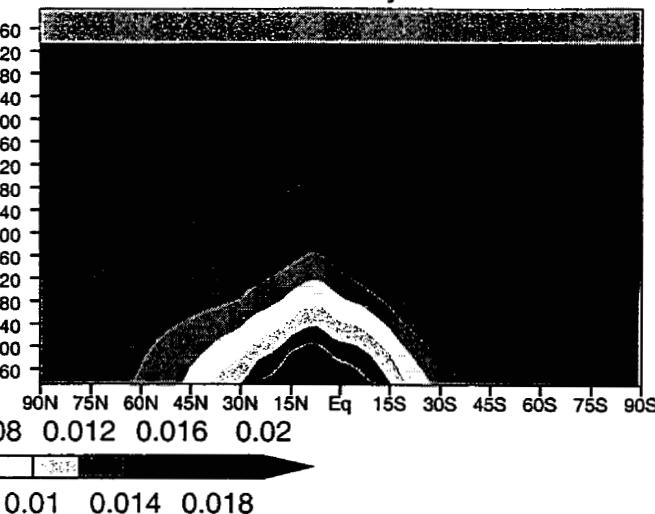


Specific humidity

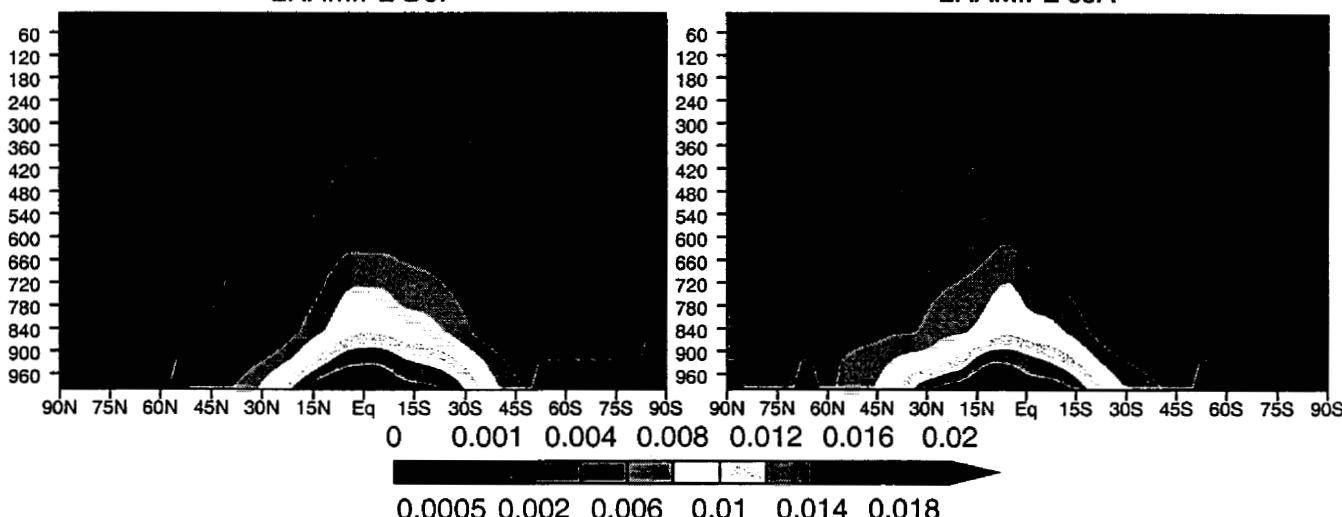
ECMWF reanalysis DJF



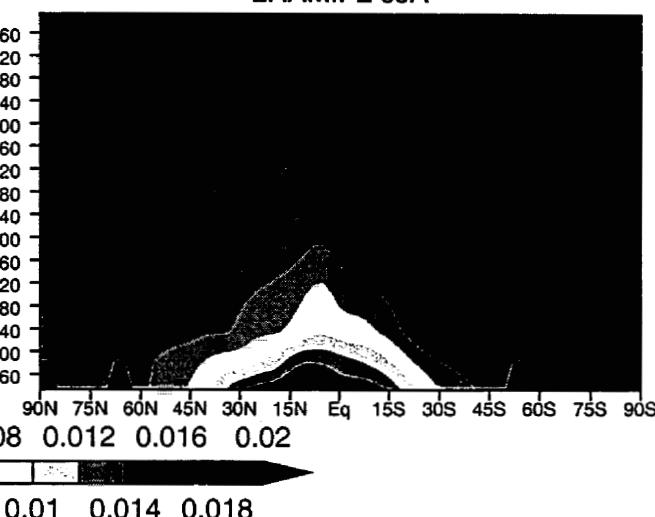
ECMWF reanalysis JJA



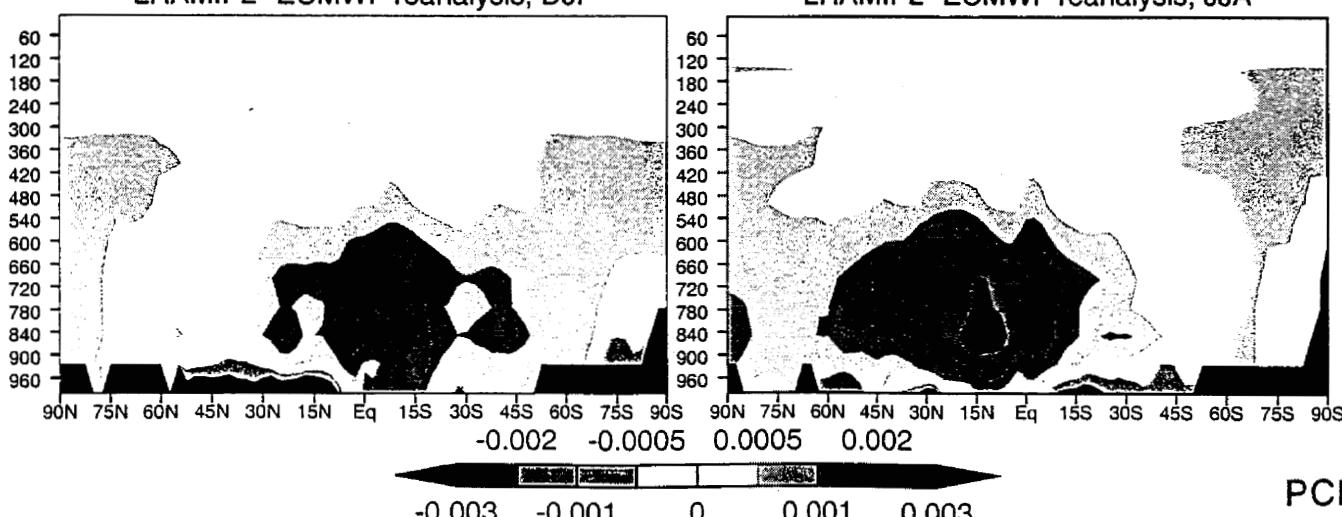
LRAMIP2 DJF



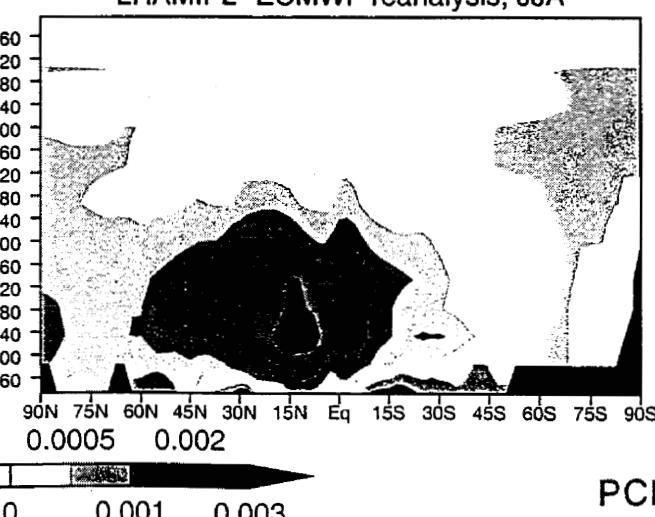
LRAMIP2 JJA



LRAMIP2- ECMWF reanalysis, DJF



LRAMIP2- ECMWF reanalysis, JJA



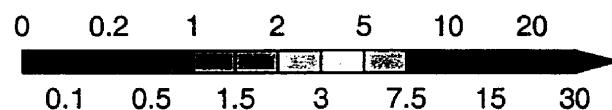
# **RAS\_AMIP2**

- CCM 3.10 physics with relaxed Arakawa-Schubert convection.
- T42, 30 levels
- AMIP2 run
- Contact: Jim Hack, NCAR,  
[hack@ucar.edu](mailto:hack@ucar.edu)

Total precipitation rate (mm/day)

Observed (CPC, Xie-Arkin), DJF

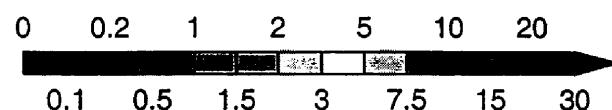
Observed (CPC, Xie-Arkin), JJA



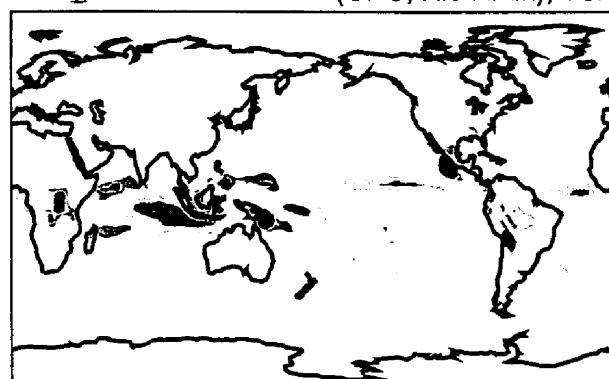
RAS\_AMIP2, DJF



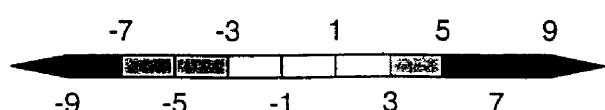
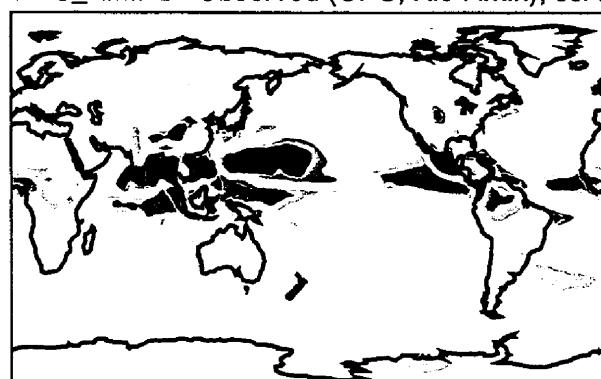
RAS\_AMIP2, JJA



RAS\_AMIP2 - Observed (CPC, Xie-Arkin), DJF



RAS\_AMIP2 - Observed (CPC, Xie-Arkin), JJA

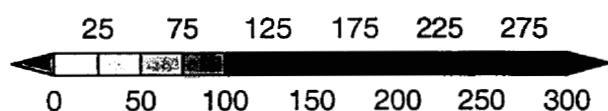


Heat flux latent surface (W/m<sup>2</sup>)

Observed (COADS), DJF



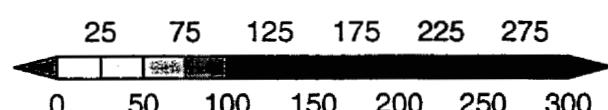
Observed (COADS), JJA



RAS\_AMIP2, DJF



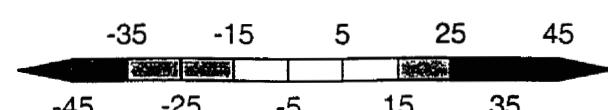
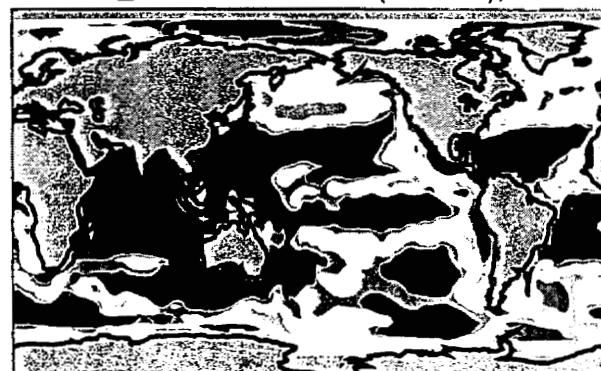
RAS\_AMIP2, JJA



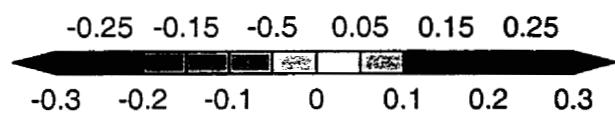
RAS\_AMIP2 - Observed (COADS), DJF



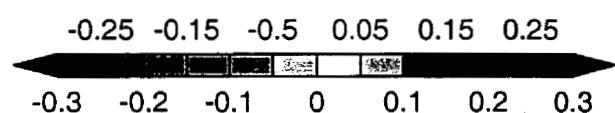
RAS\_AMIP2 - Observed (COADS), JJA



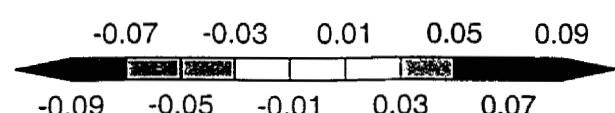
Eastward surface wind stress (positive for eastward wind) ( $\text{N/m}^2$ )  
UWMCOADS, DJF      UWMCOADS, JJA



RAS\_AMIP2, DJF



RAS\_AMIP2 - UWMCOADS, DJF

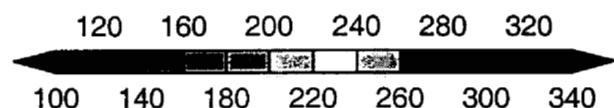


LW radiation TOA (OLR) (W/m<sup>2</sup>)

Observed (ERBE), DJF



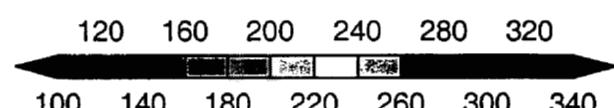
Observed (ERBE), JJA



RAS\_AMIP2, DJF



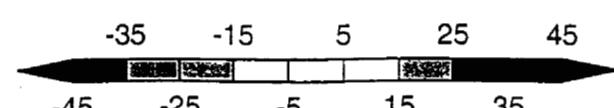
RAS\_AMIP2, JJA



RAS\_AMIP2 - Observed (ERBE), DJF



RAS\_AMIP2 - Observed (ERBE), JJA



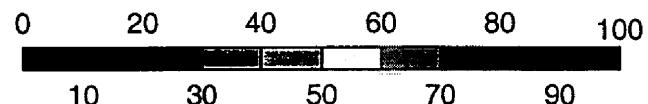
# RAS\_AMIP2

Total Cloud Amount (%)

Observed (ISCCP), DJF



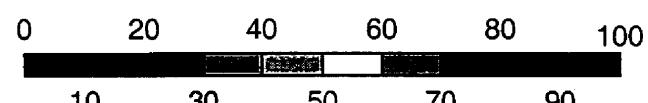
Observed (ISCCP), JJA



RAS\_AMIP2, DJF



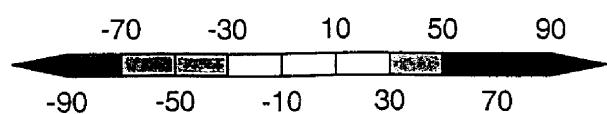
RAS\_AMIP2, JJA



RAS\_AMIP2 - Observed (ISCCP), DJF



RAS\_AMIP2 - Observed (ISCCP), JJA



Sea Level Pressure (hPa)

Observed (ECMWF Reanalysis), DJF



Observed (ECMWF Reanalysis), JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

RAS\_AMIP2, DJF



RAS\_AMIP2, JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

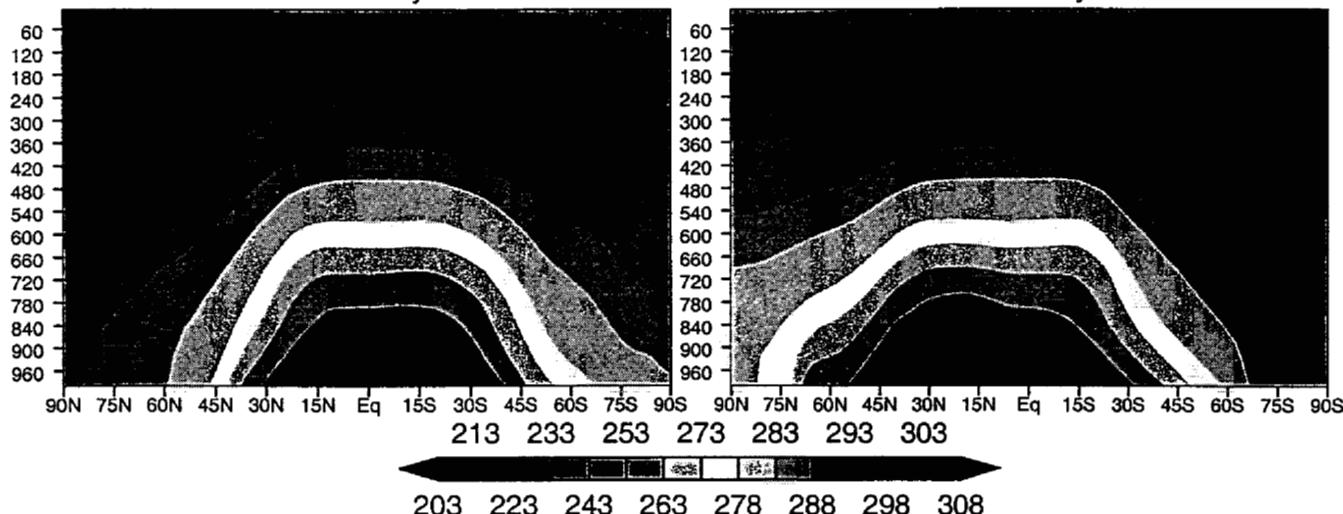
RAS\_AMIP2 - Observed (ECMWF Reanalysis), DJF      RAS\_AMIP2 - Observed (ECMWF Reanalysis), JJA



-7 -5 -3 1 3 5 7

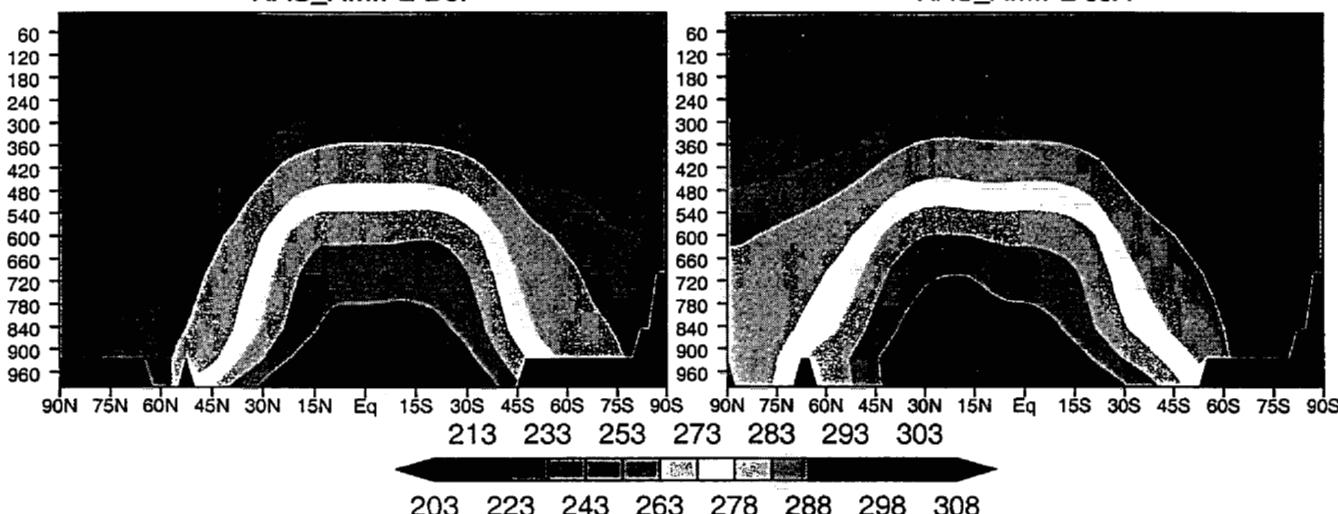
Air Temperature

ECMWF reanalysis DJF



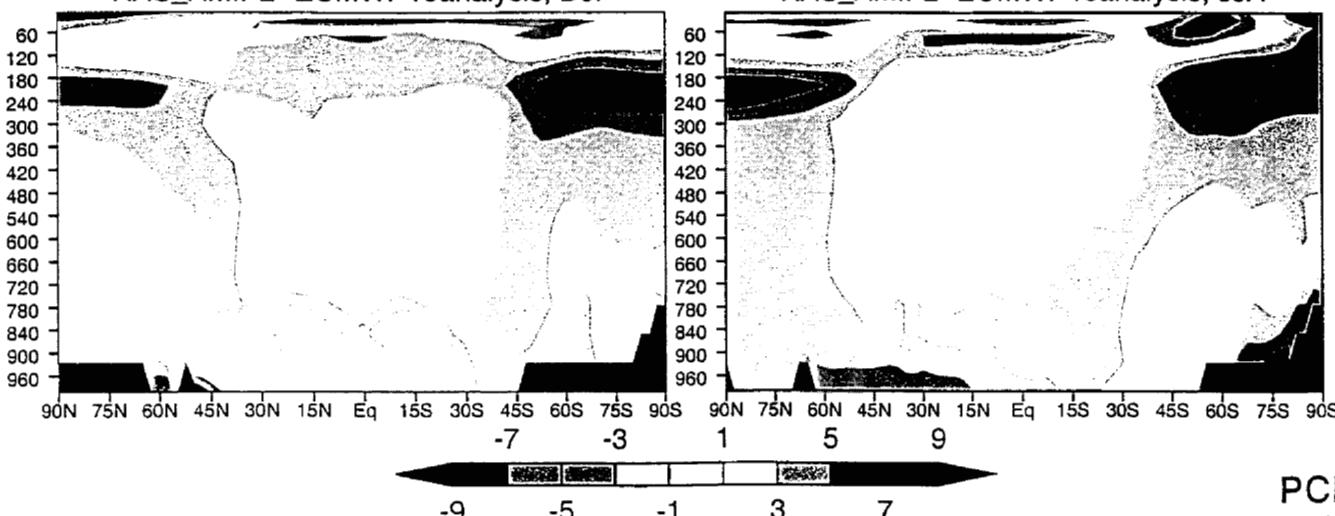
ECMWF reanalysis JJA

RAS\_AMIP2 DJF



RAS\_AMIP2 JJA

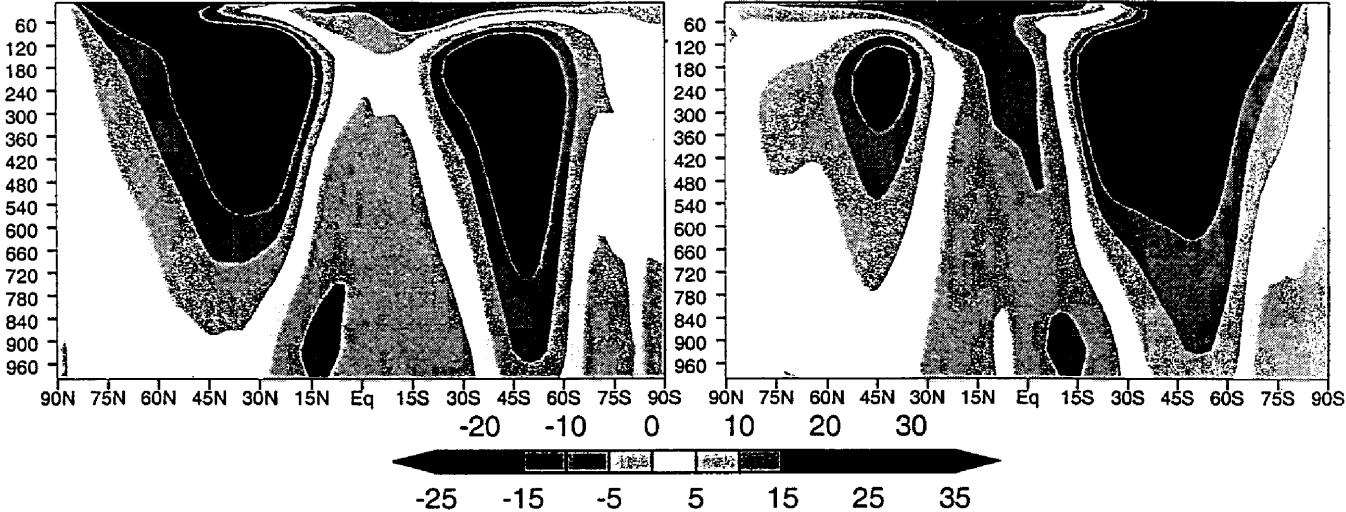
RAS\_AMIP2- ECMWF reanalysis, DJF



RAS\_AMIP2- ECMWF reanalysis, JJA

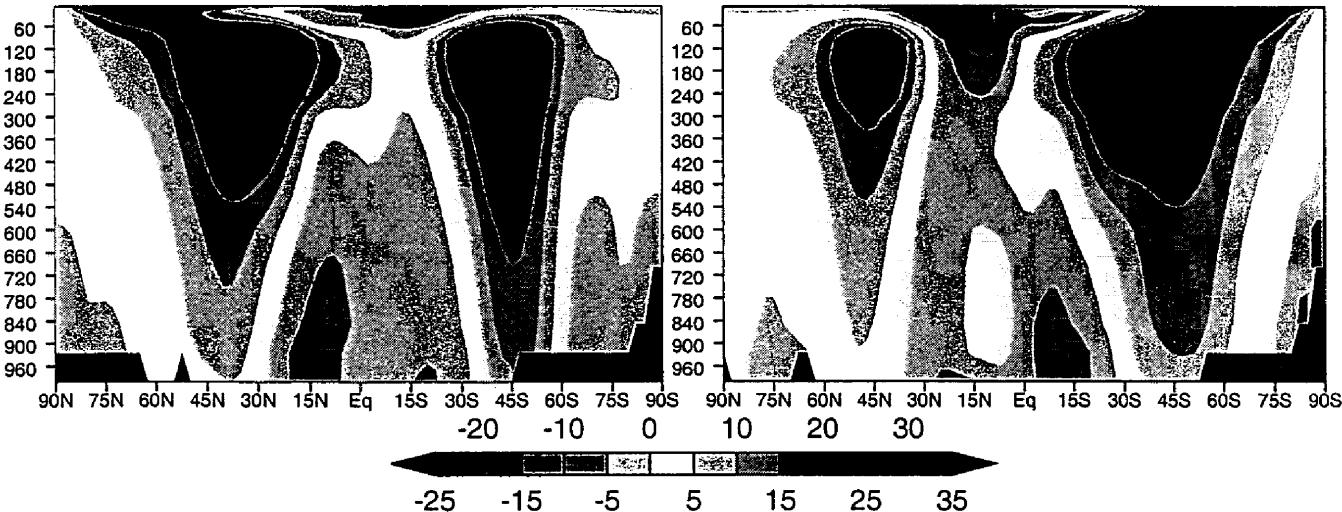
Eastward wind

ECMWF reanalysis DJF



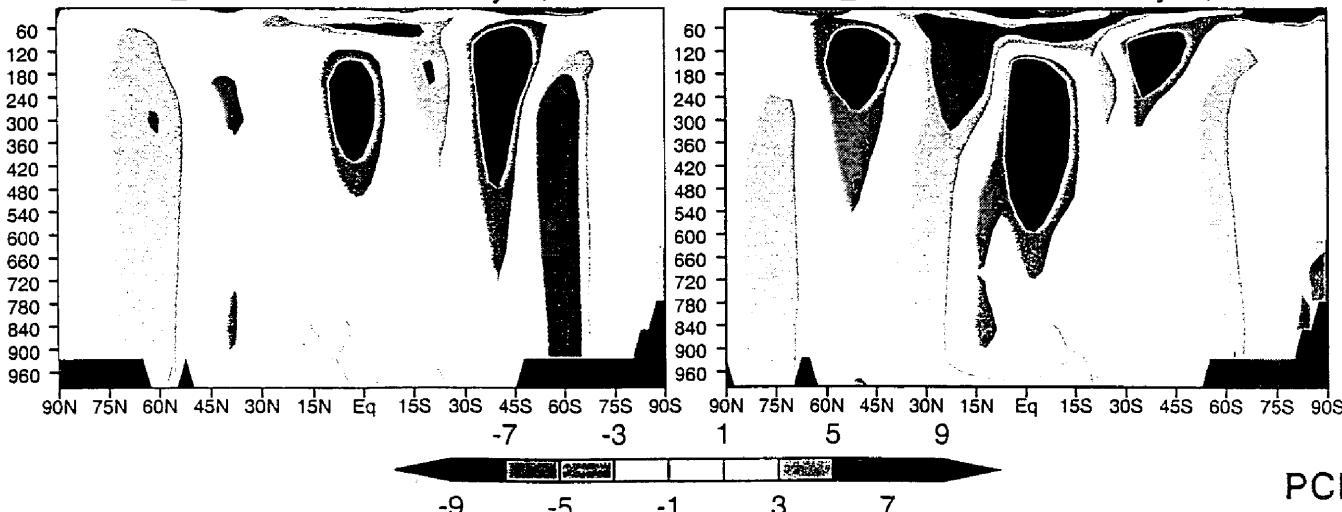
ECMWF reanalysis JJA

RAS\_AMIP2 DJF



RAS\_AMIP2 JJA

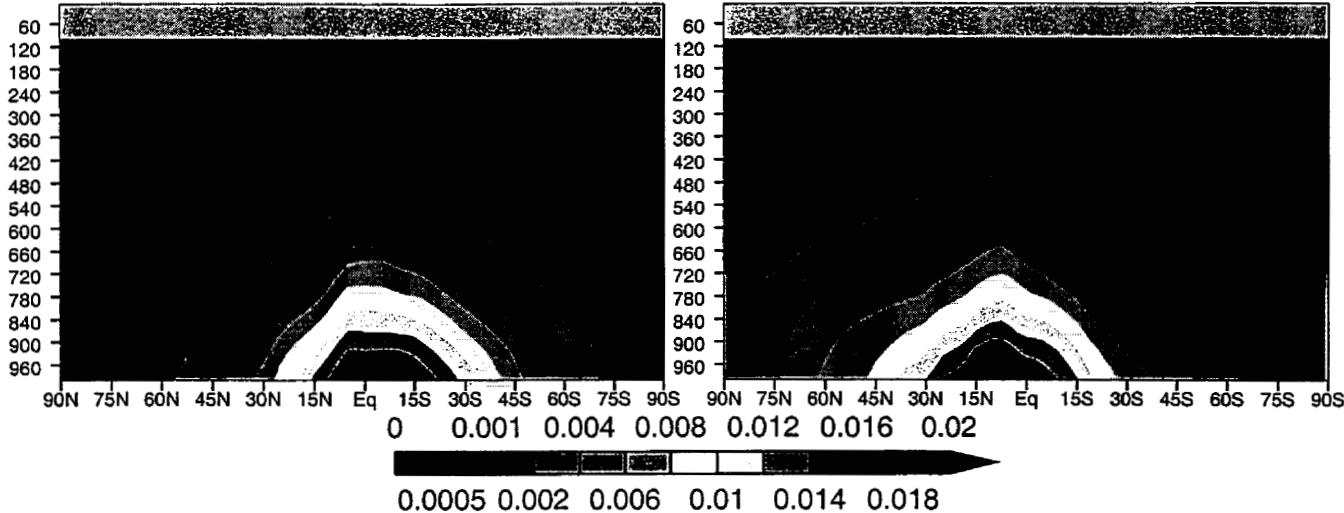
RAS\_AMIP2- ECMWF reanalysis, DJF



RAS\_AMIP2- ECMWF reanalysis, JJA

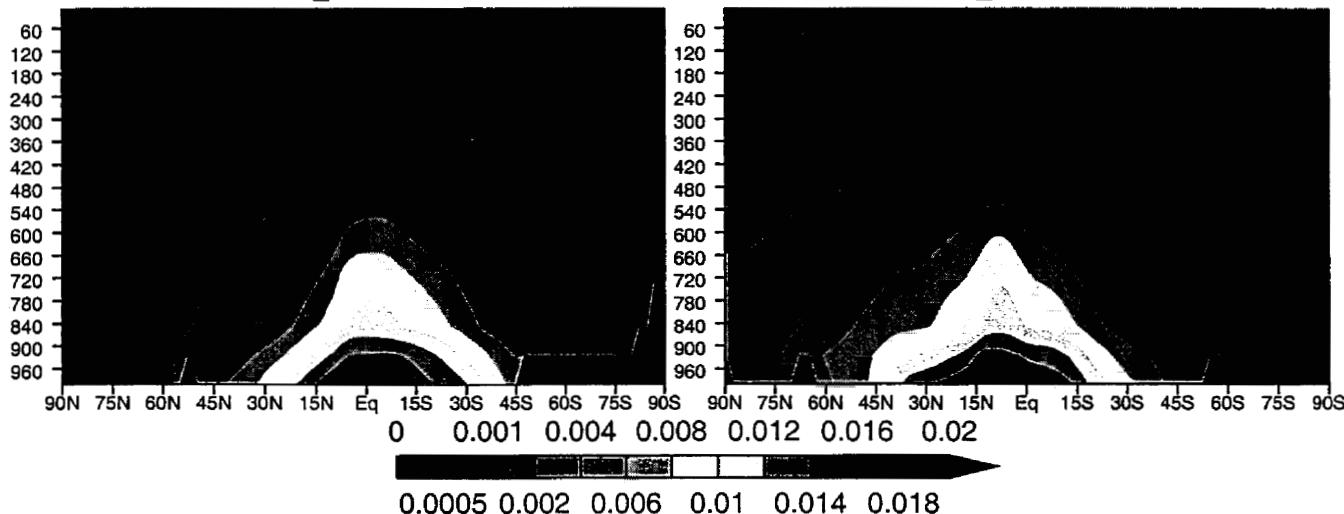
Specific humidity

ECMWF reanalysis DJF



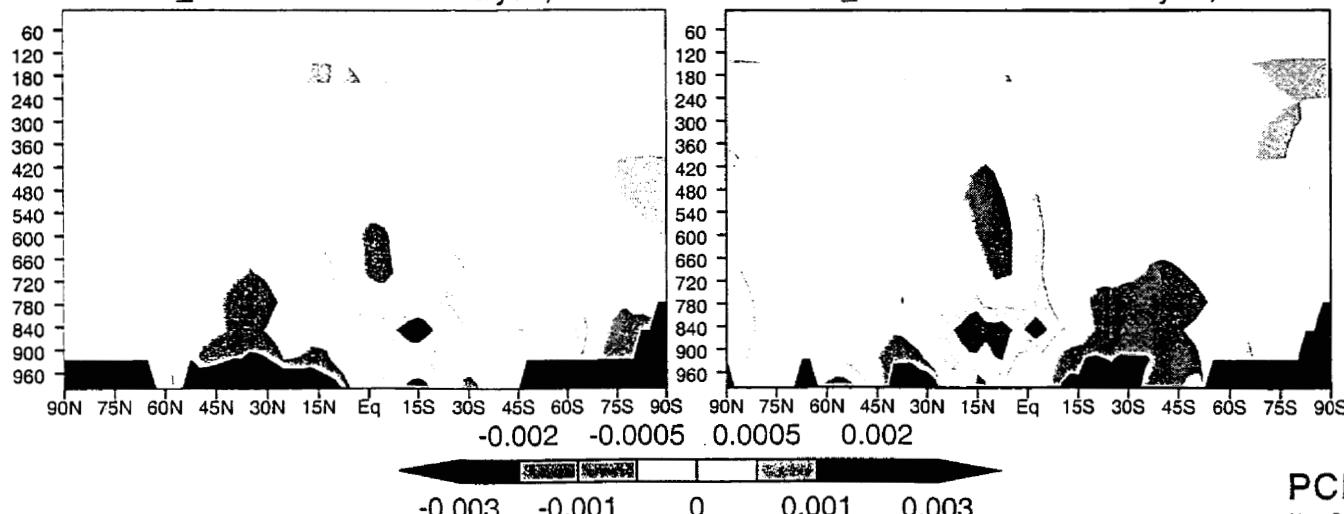
ECMWF reanalysis JJA

RAS\_AMIP2 DJF

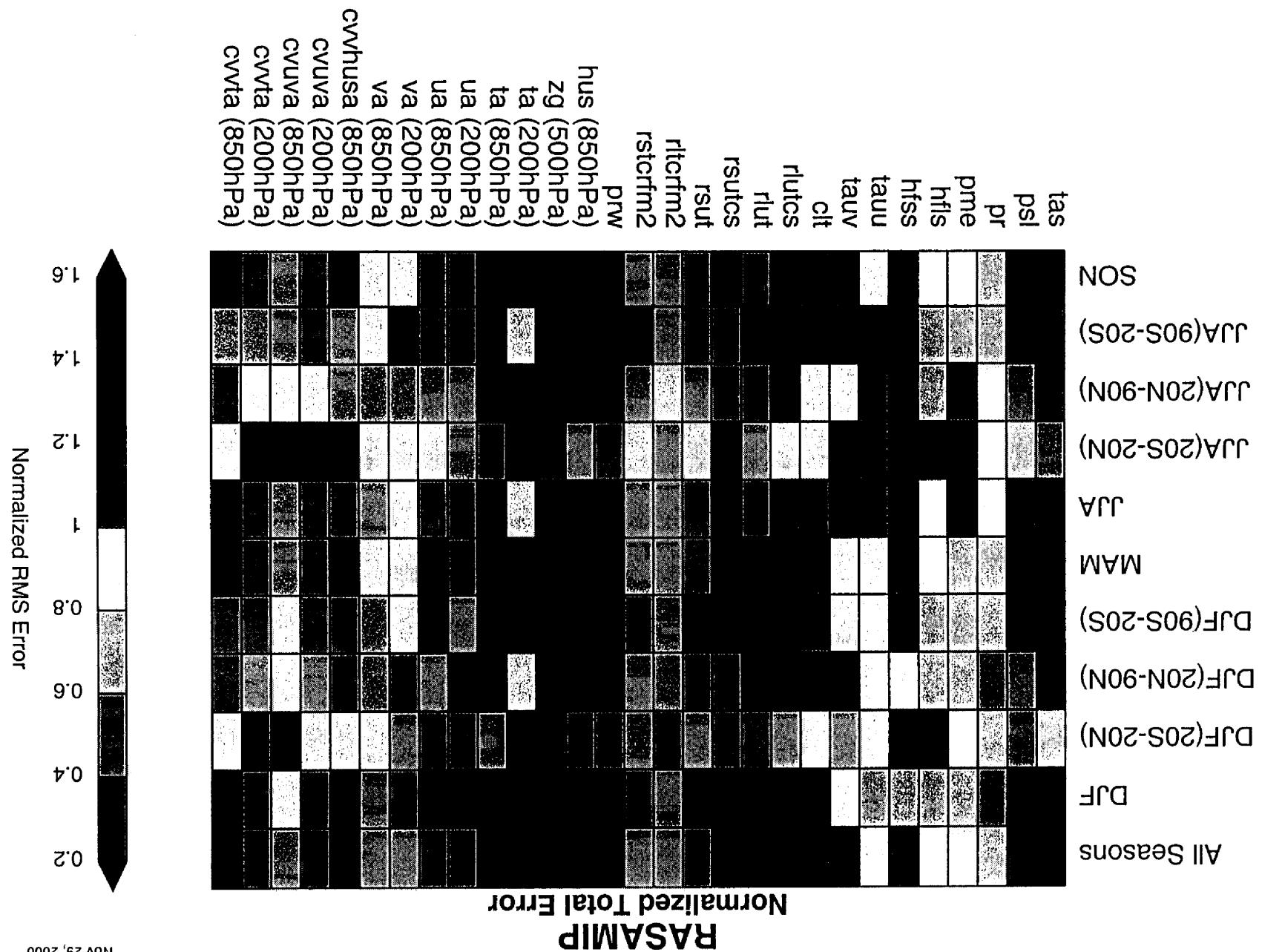


RAS\_AMIP2 JJA

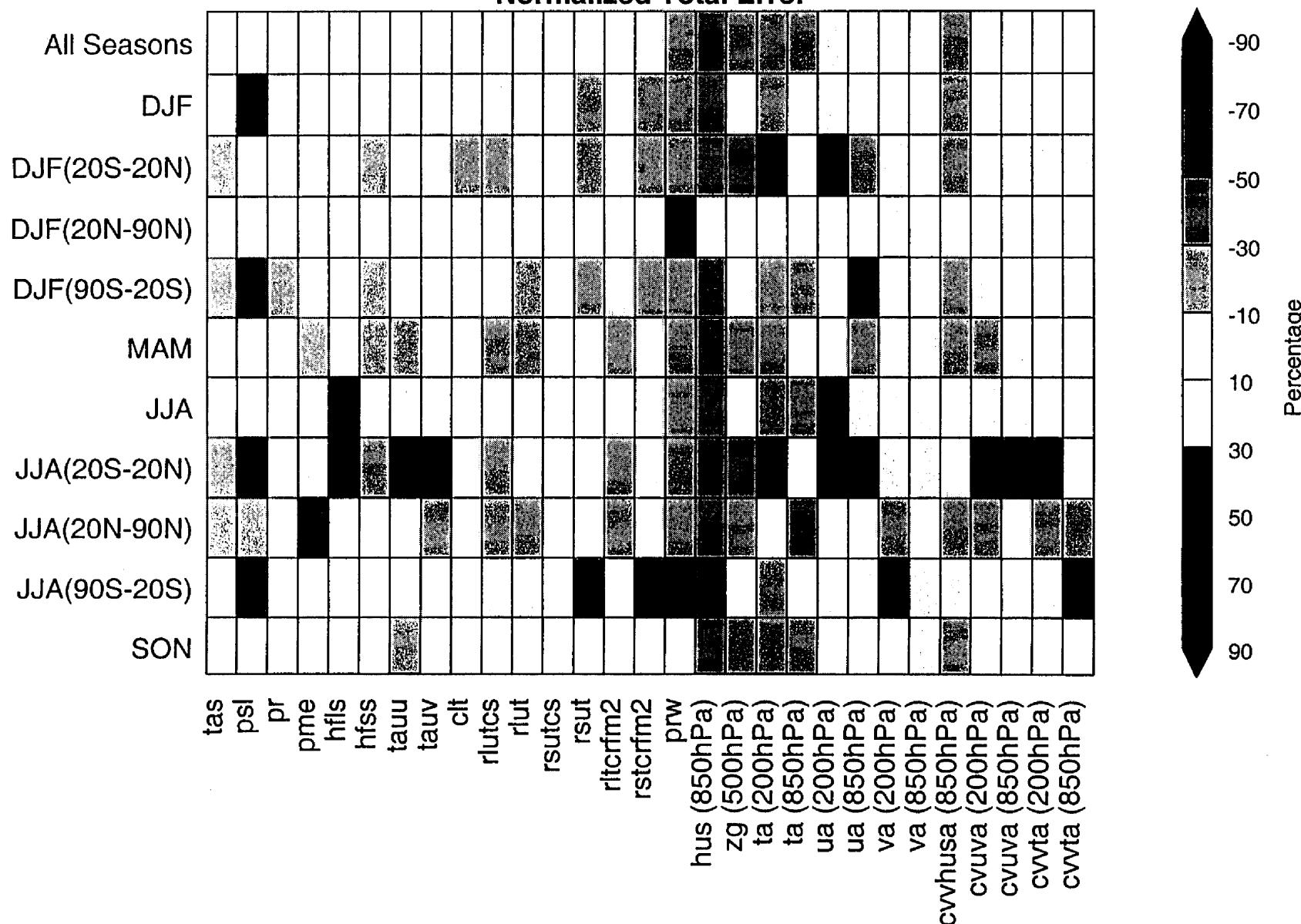
RAS\_AMIP2- ECMWF reanalysis, DJF



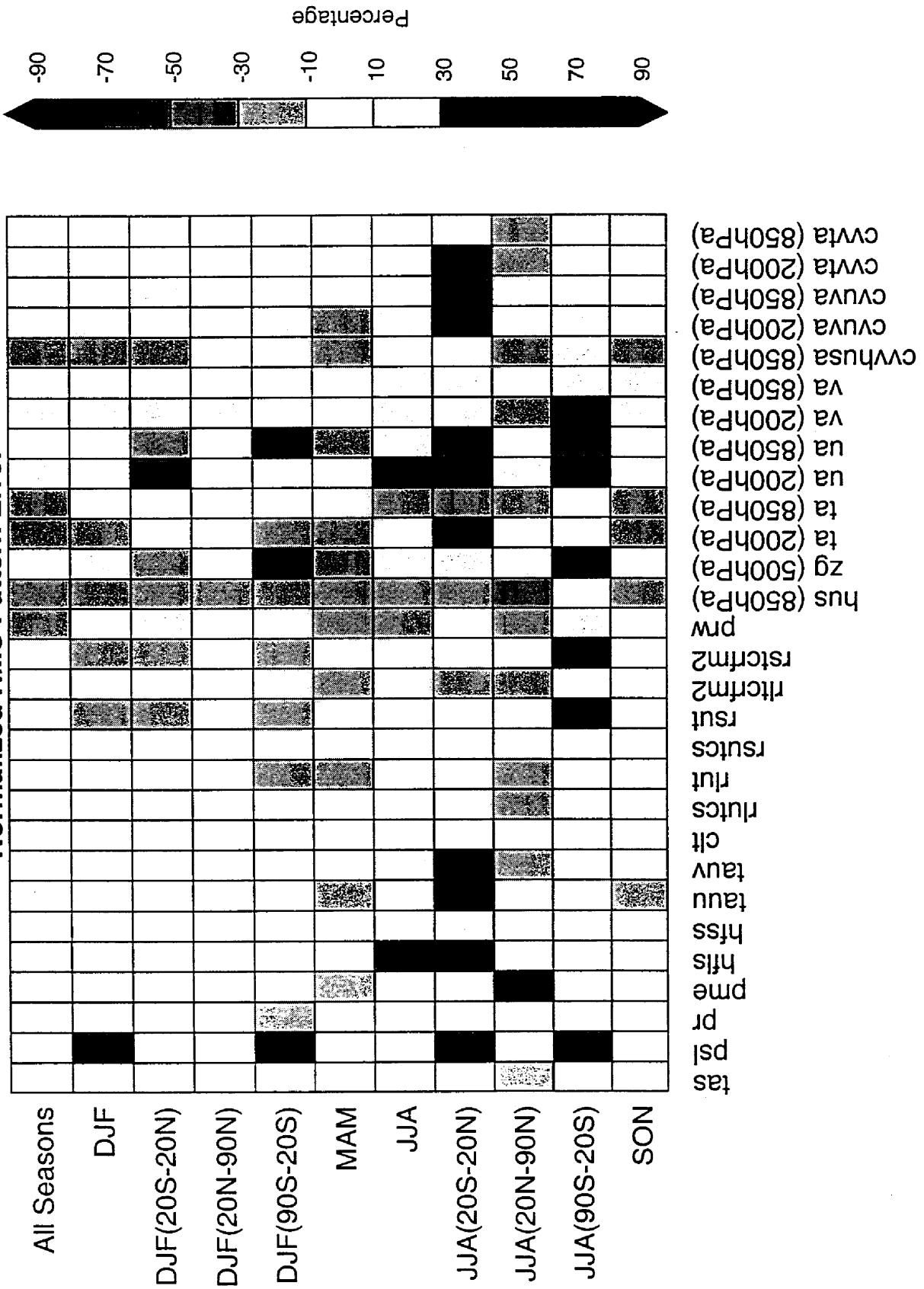
RAS\_AMIP2- ECMWF reanalysis, JJA



## RAS\_AMIP: Percentage Difference from CCM3.9.11 AMIP2 Normalized Total Error

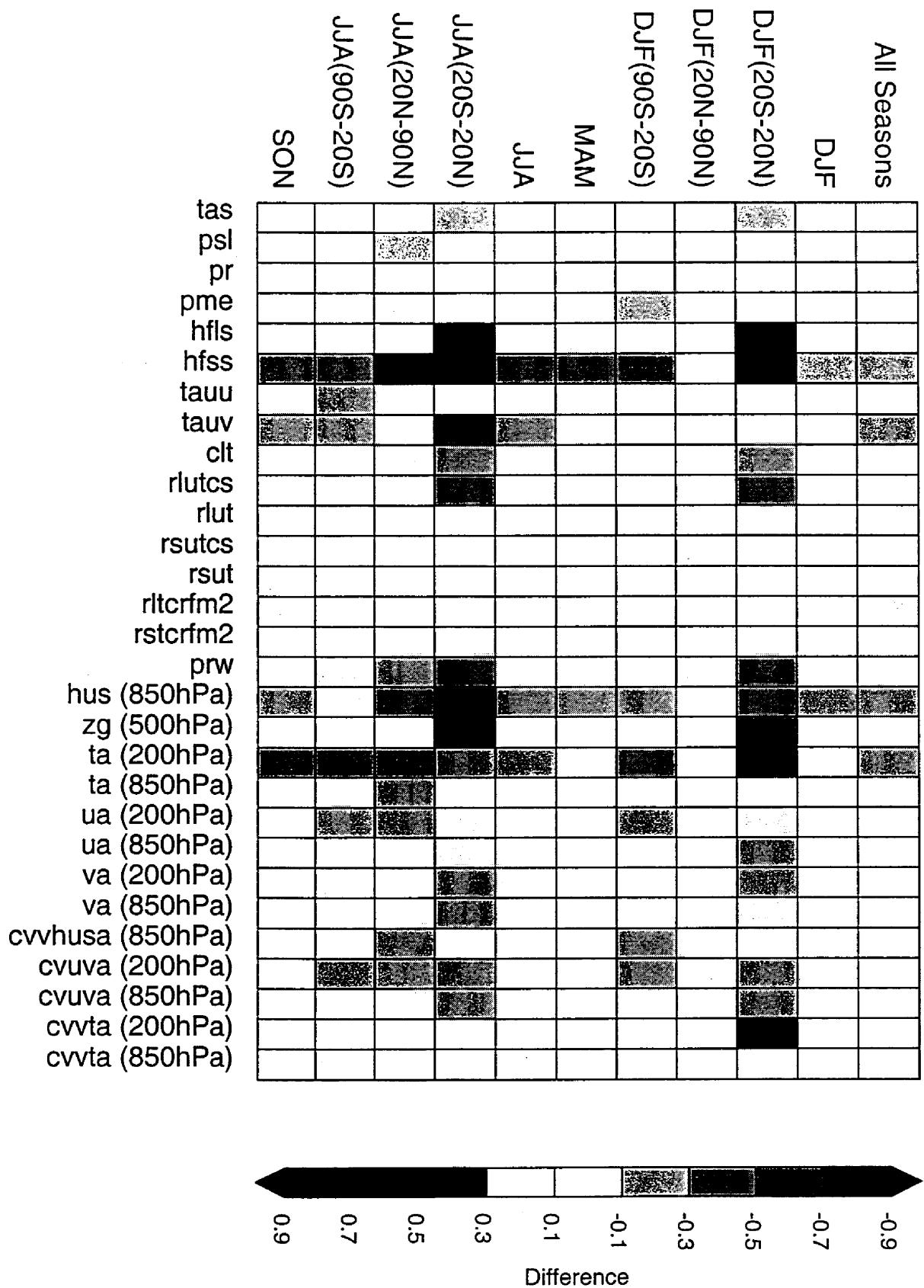


## RAS\_AMIP: Percentage Difference from CCM3.9.11 AMIP2



# RAS\_AMIP: Absolute Difference from CCM3.9.11 AMIP2

Normalized Bias



# **CSU\_AMIP2**

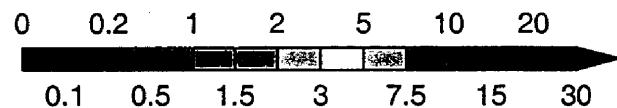
- Arakawa-Schubert convection scheme
- T42, 30 levels
- AMIP2 run
- Contact: M. Khairoutdinov, Colorado State University,  
[marat@inferno.atmos.colostate.edu](mailto:marat@inferno.atmos.colostate.edu)

Total precipitation rate (mm/day)

Observed (CPC, Xie-Arkin), DJF



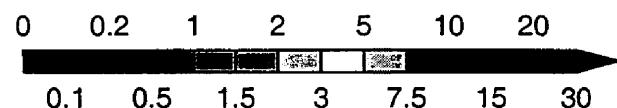
Observed (CPC, Xie-Arkin), JJA



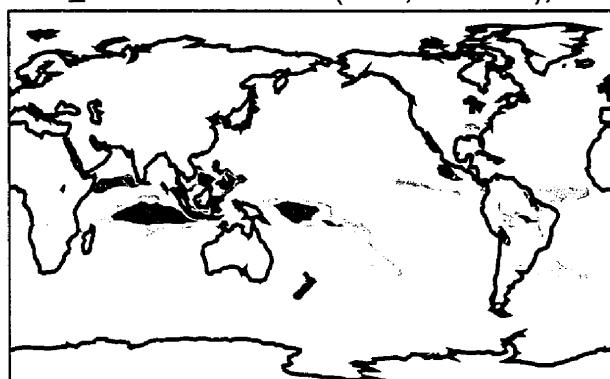
CSU\_AMIP2, DJF



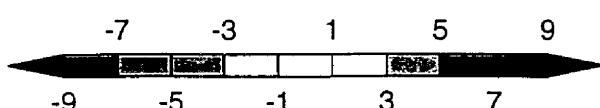
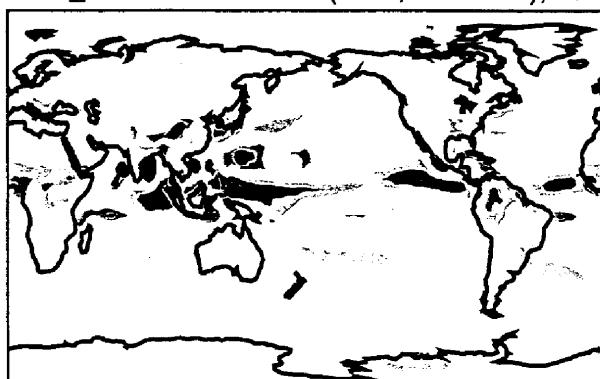
CSU\_AMIP2, JJA



CSU\_AMIP2 - Observed (CPC, Xie-Arkin), DJF



CSU\_AMIP2 - Observed (CPC, Xie-Arkin), JJA

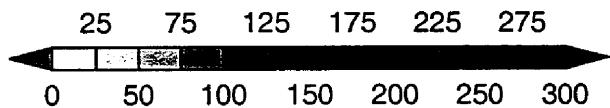


Heat flux latent surface ( $\text{W/m}^2$ )

Observed (COADS), DJF



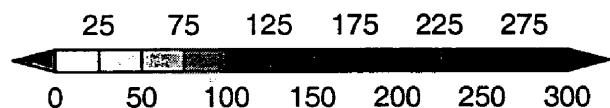
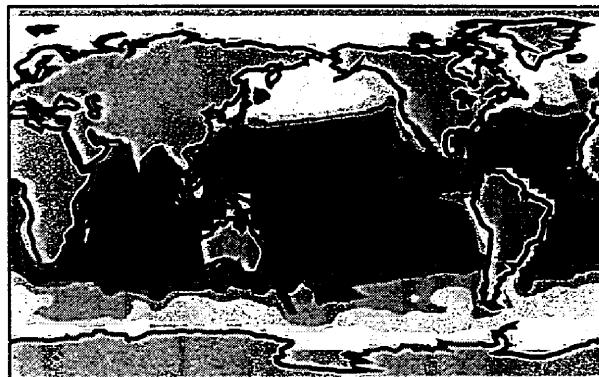
Observed (COADS), JJA



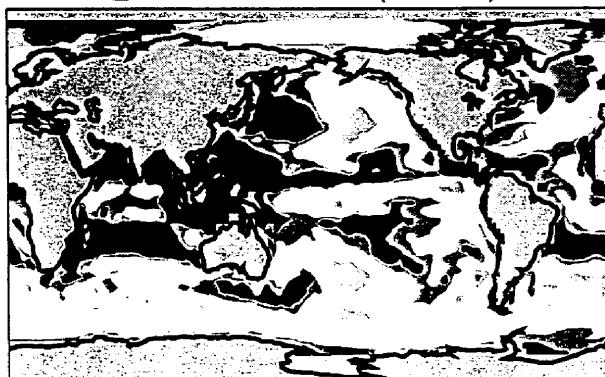
CSU\_AMIP2, DJF



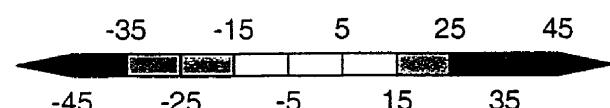
CSU\_AMIP2, JJA



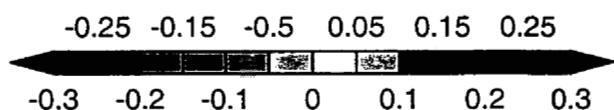
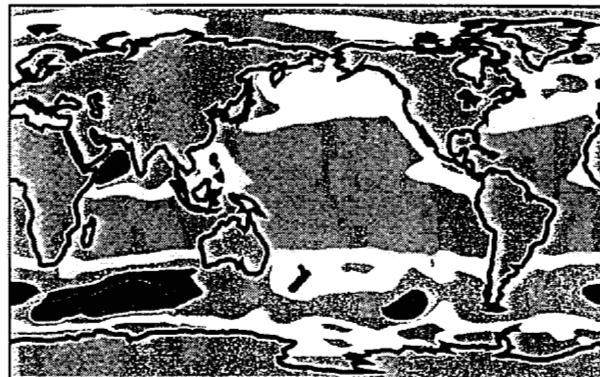
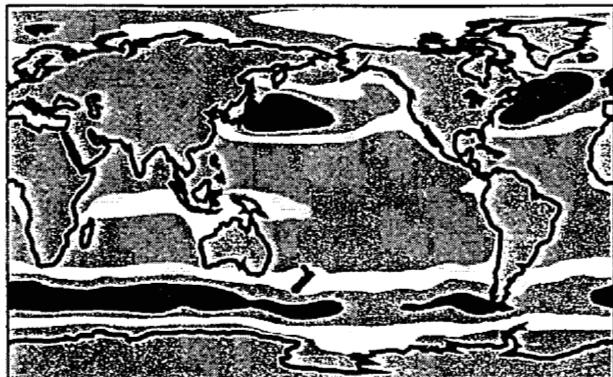
CSU\_AMIP2 - Observed (COADS), DJF



CSU\_AMIP2 - Observed (COADS), JJA



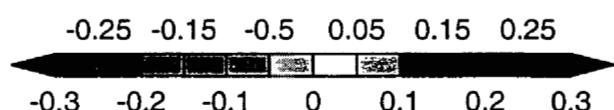
Eastward surface wind stress (positive for eastward wind) ( $\text{N/m}^2$ )  
UWMCOADS, DJF



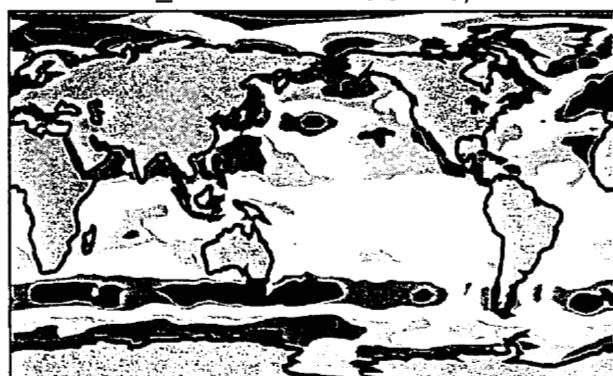
CSU\_AMIP2, DJF



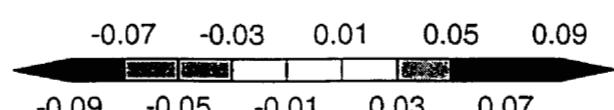
CSU\_AMIP2, JJA



CSU\_AMIP2 - UWMCOADS, DJF



CSU\_AMIP2 - UWMCOADS, JJA



LW radiation TOA (OLR) (W/m<sup>2</sup>)

Observed (ERBE), DJF



Observed (ERBE), JJA



120 160 200 240 280 320

100 140 180 220 260 300 340

CSU\_AMIP2, DJF



CSU\_AMIP2, JJA



120 160 200 240 280 320

100 140 180 220 260 300 340

CSU\_AMIP2 - Observed (ERBE), DJF

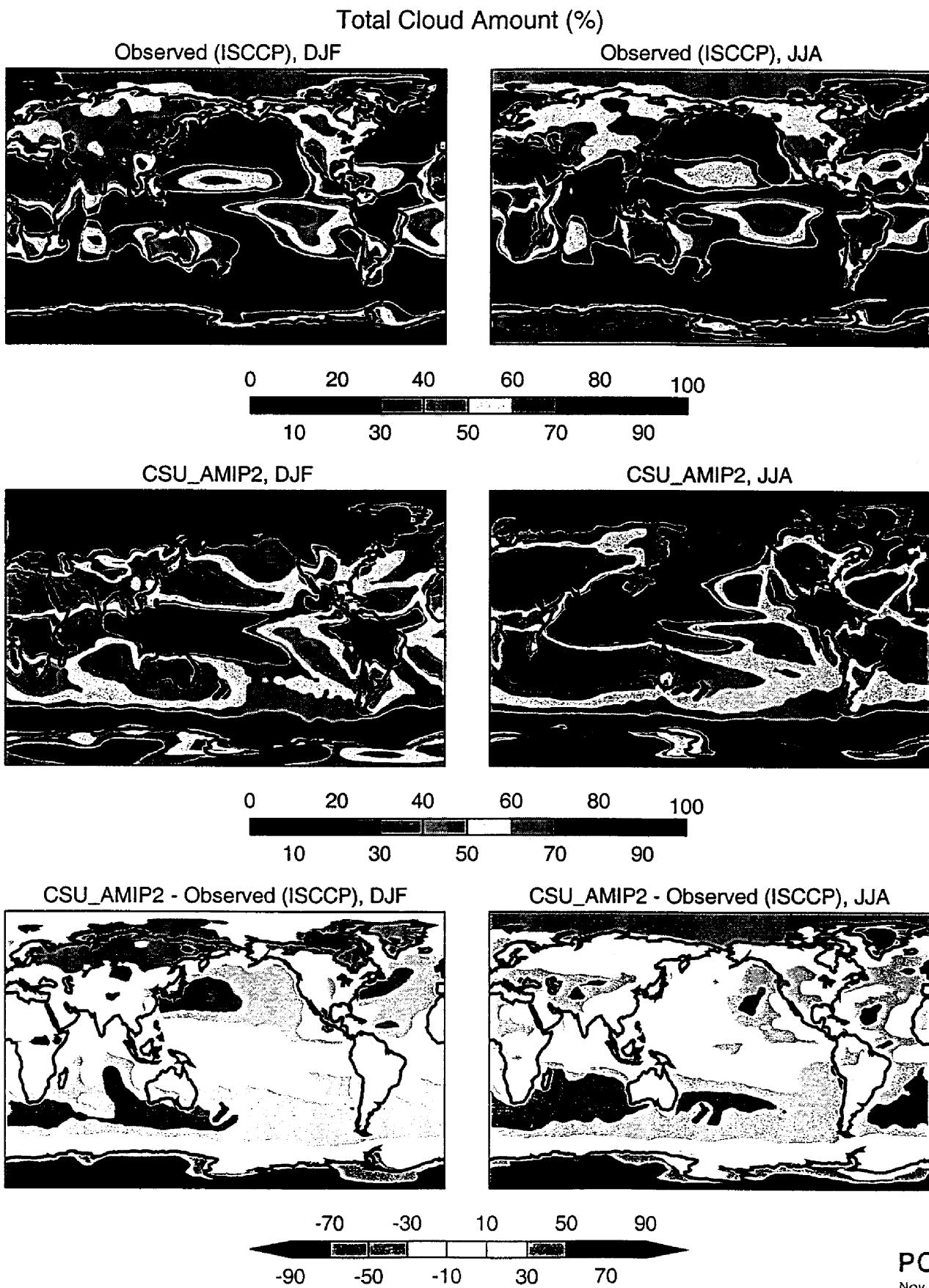


CSU\_AMIP2 - Observed (ERBE), JJA



-35 -15 5 25 45

-45 -25 -5 15 35



Sea Level Pressure (hPa)

Observed (ECMWF Reanalysis), DJF



Observed (ECMWF Reanalysis), JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

CSU\_AMIP2, DJF



CSU\_AMIP2, JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

CSU\_AMIP2 - Observed (ECMWF Reanalysis), DJF CSU\_AMIP2 - Observed (ECMWF Reanalysis), JJA

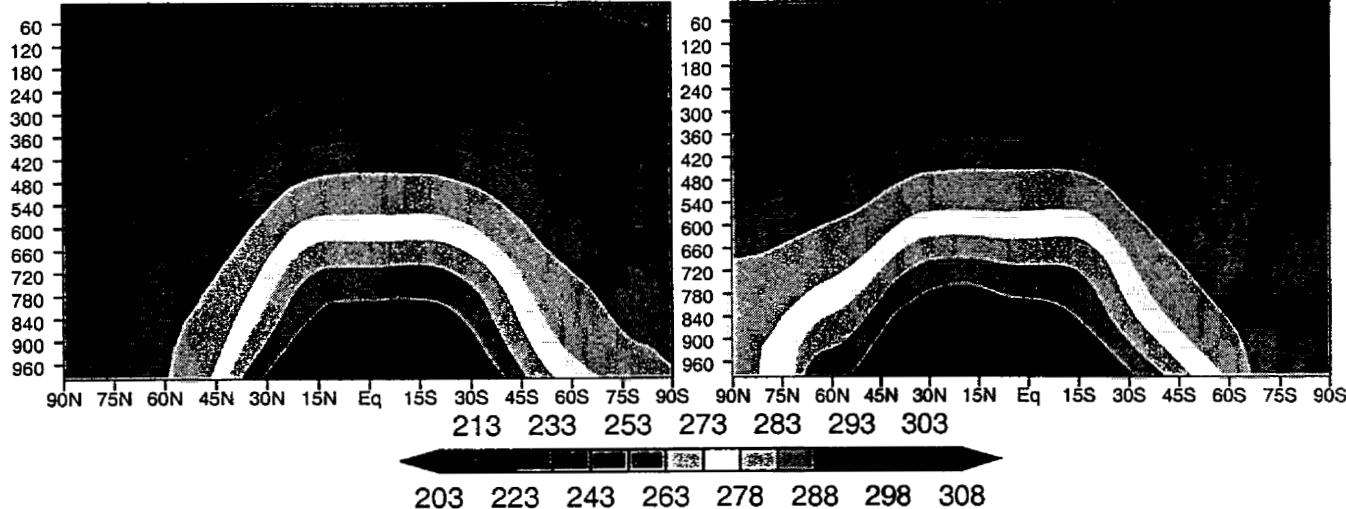


-7 -3 1 5 9

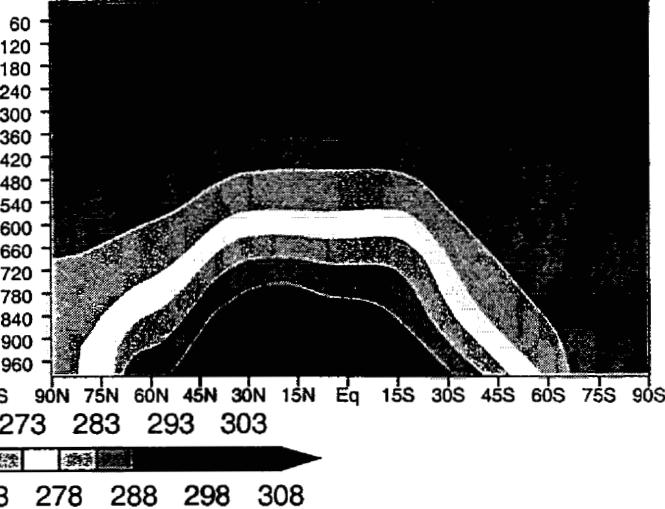
-9 -5 -1 3 7

Air Temperature

ECMWF reanalysis DJF

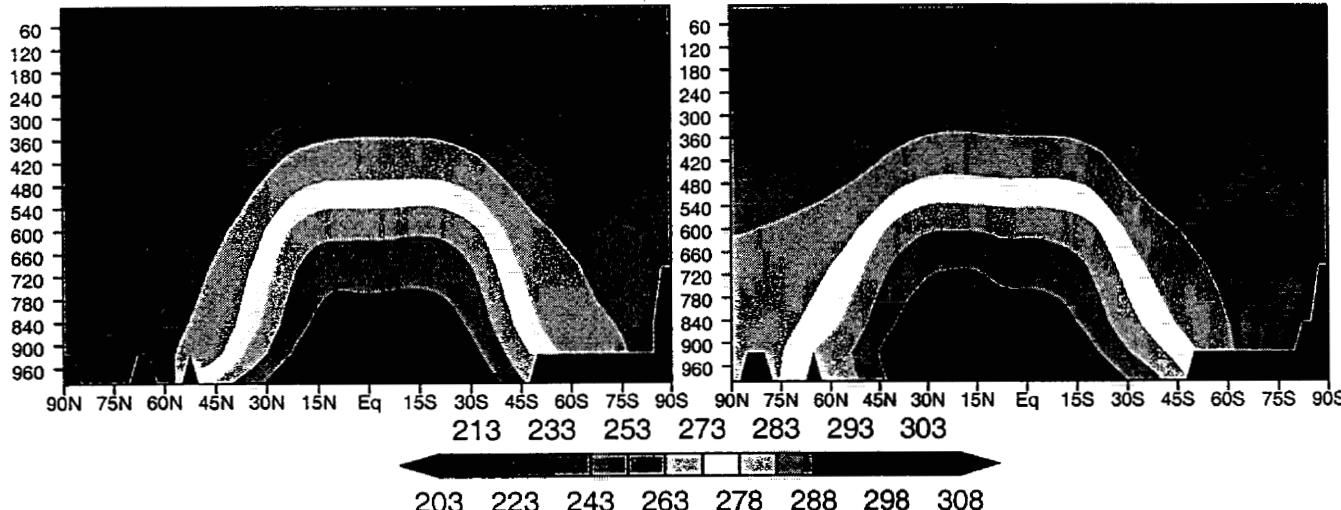


ECMWF reanalysis JJA



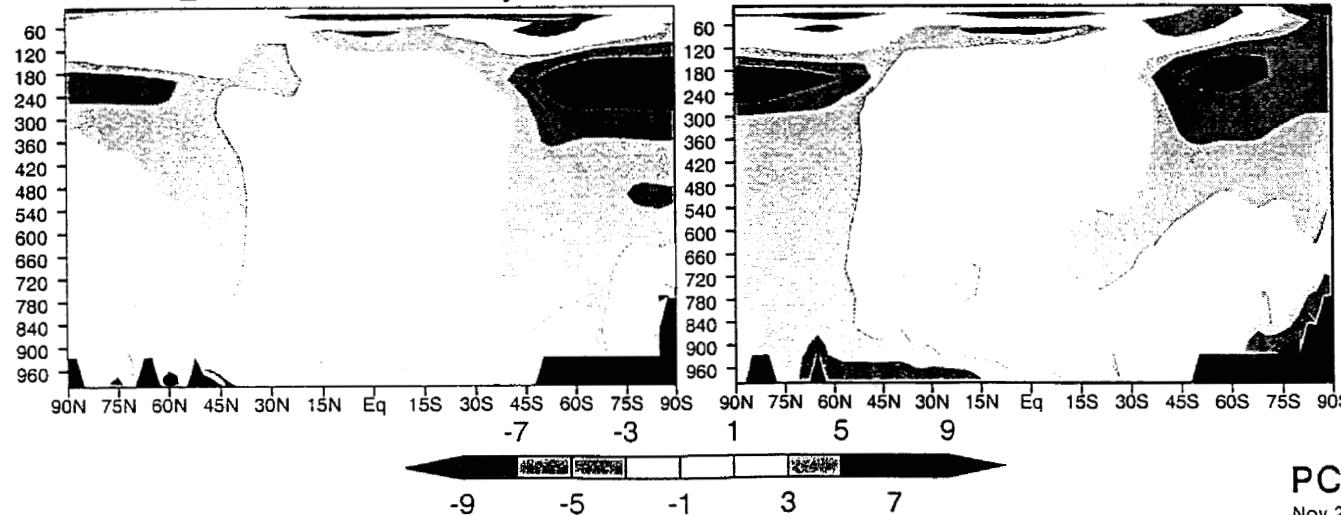
CSU\_AMIP2 DJF

CSU\_AMIP2 JJA



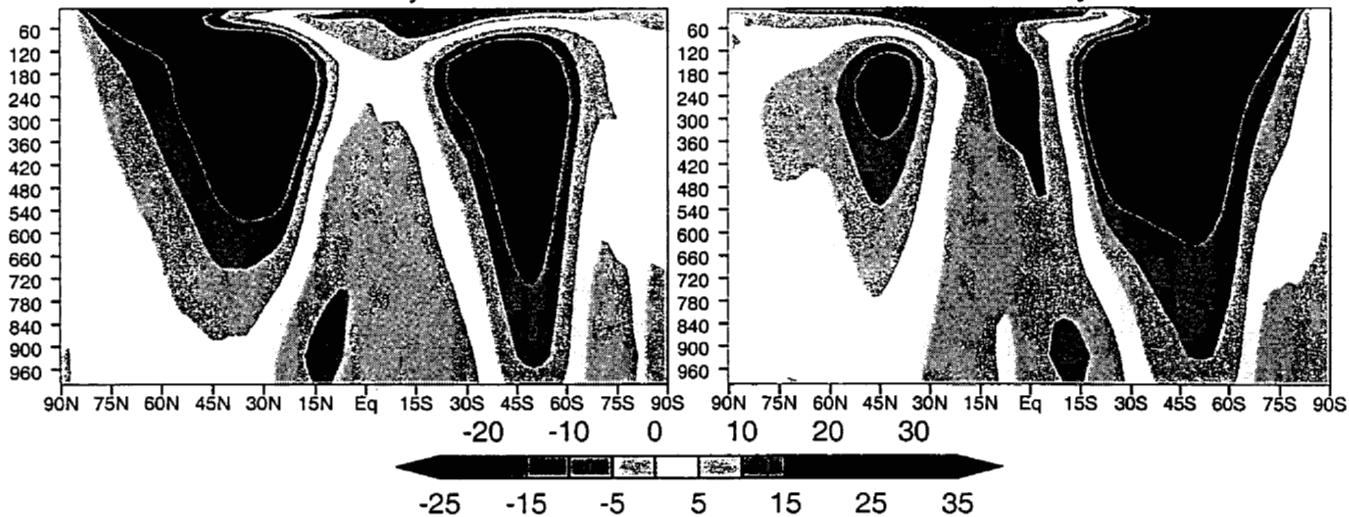
CSU\_AMIP2- ECMWF reanalysis, DJF

CSU\_AMIP2- ECMWF reanalysis, JJA



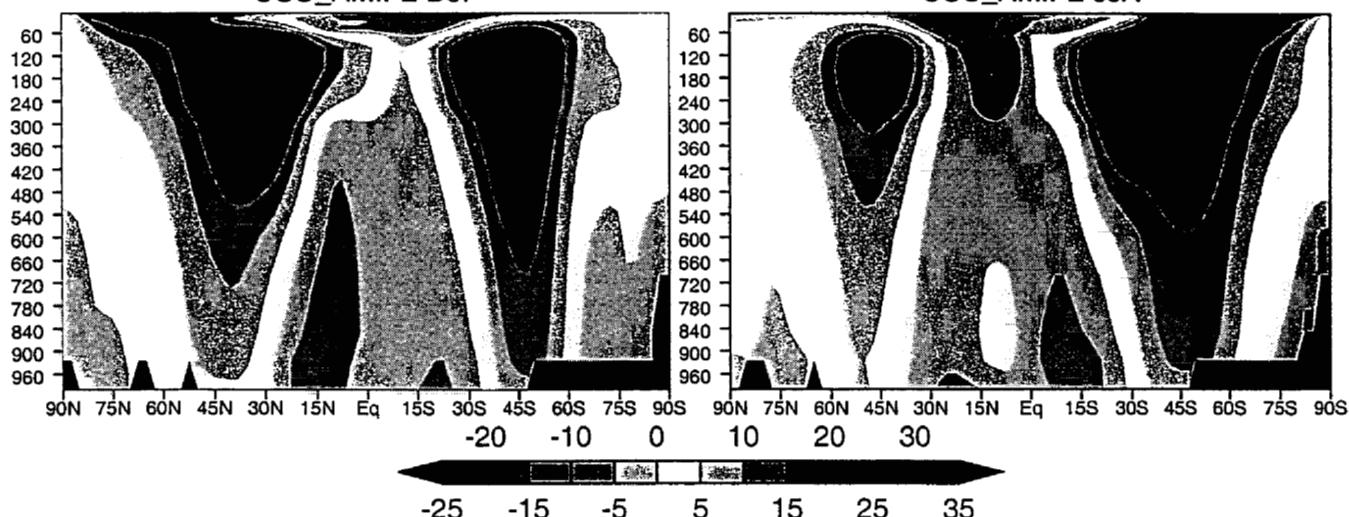
Eastward wind

ECMWF reanalysis DJF

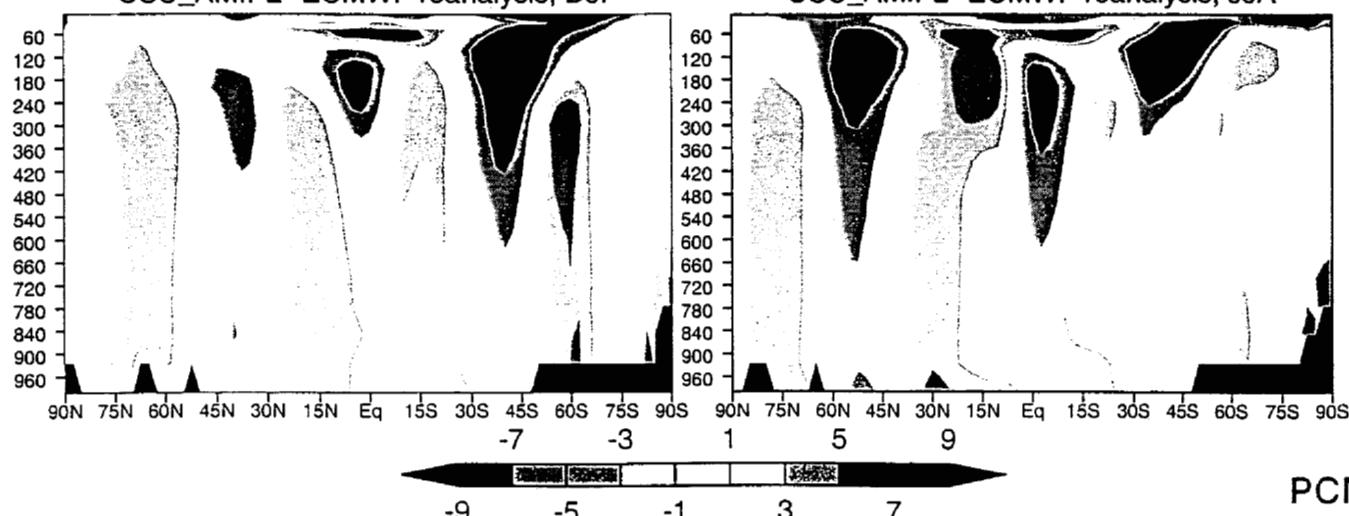


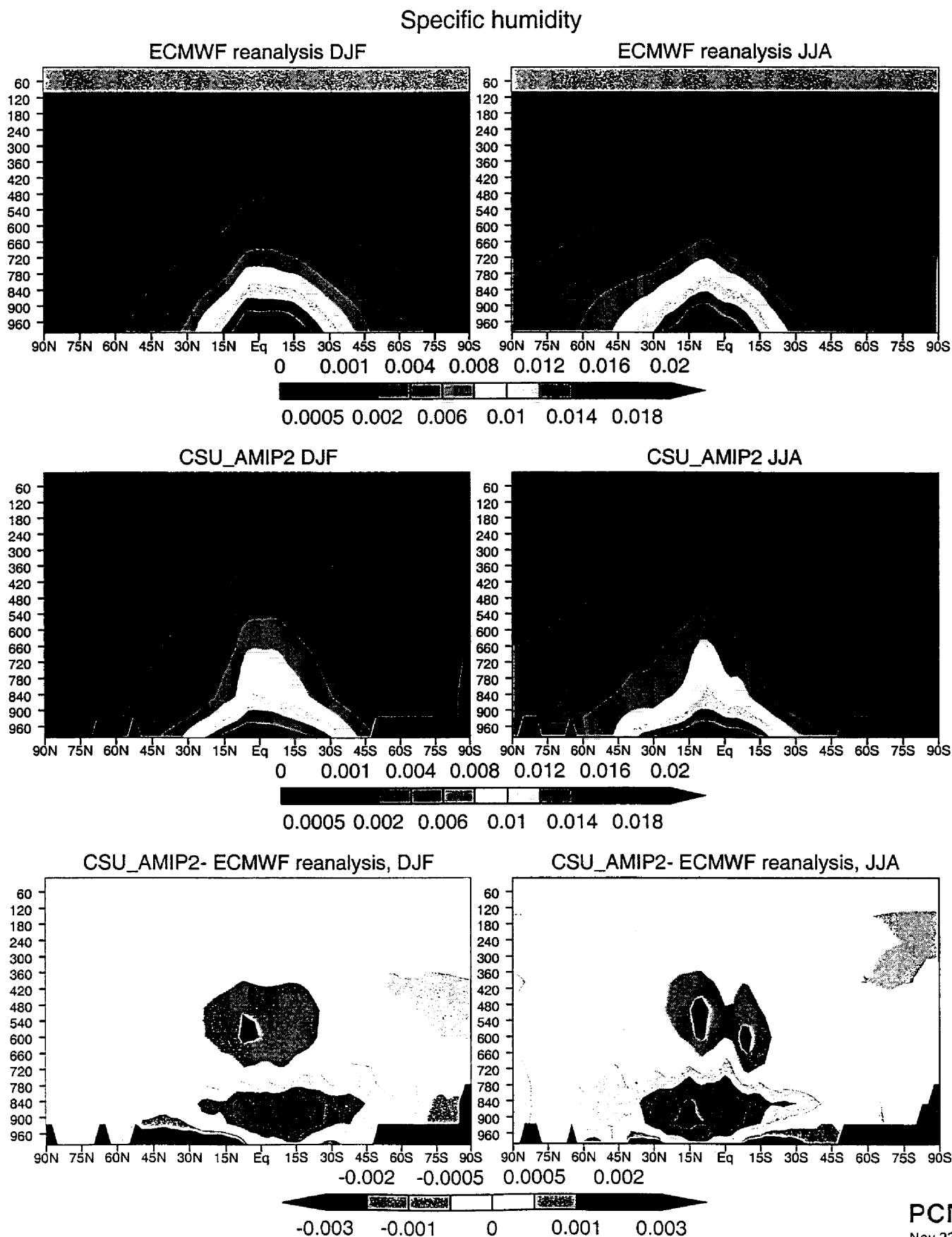
ECMWF reanalysis JJA

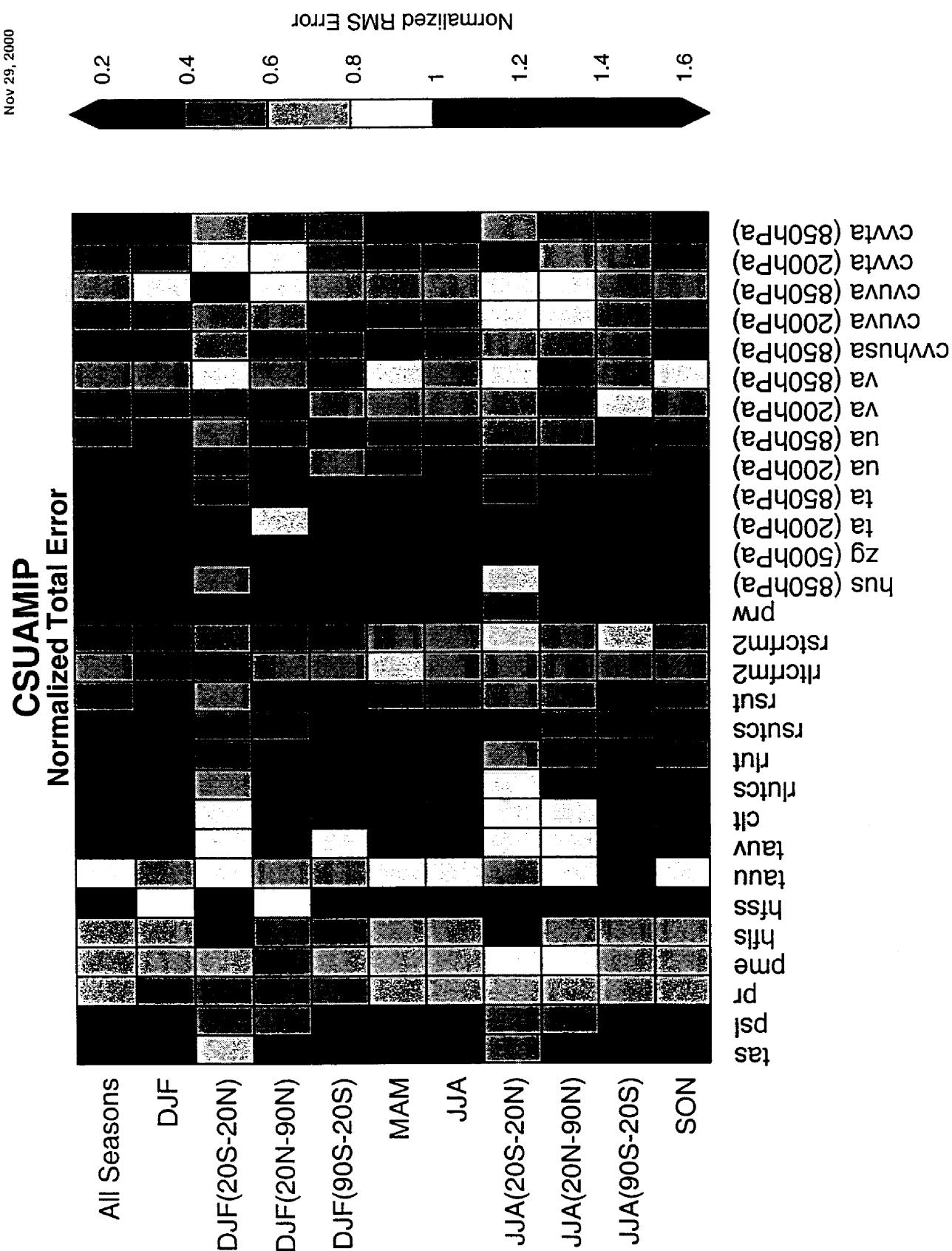
CSU\_AMIP2 DJF



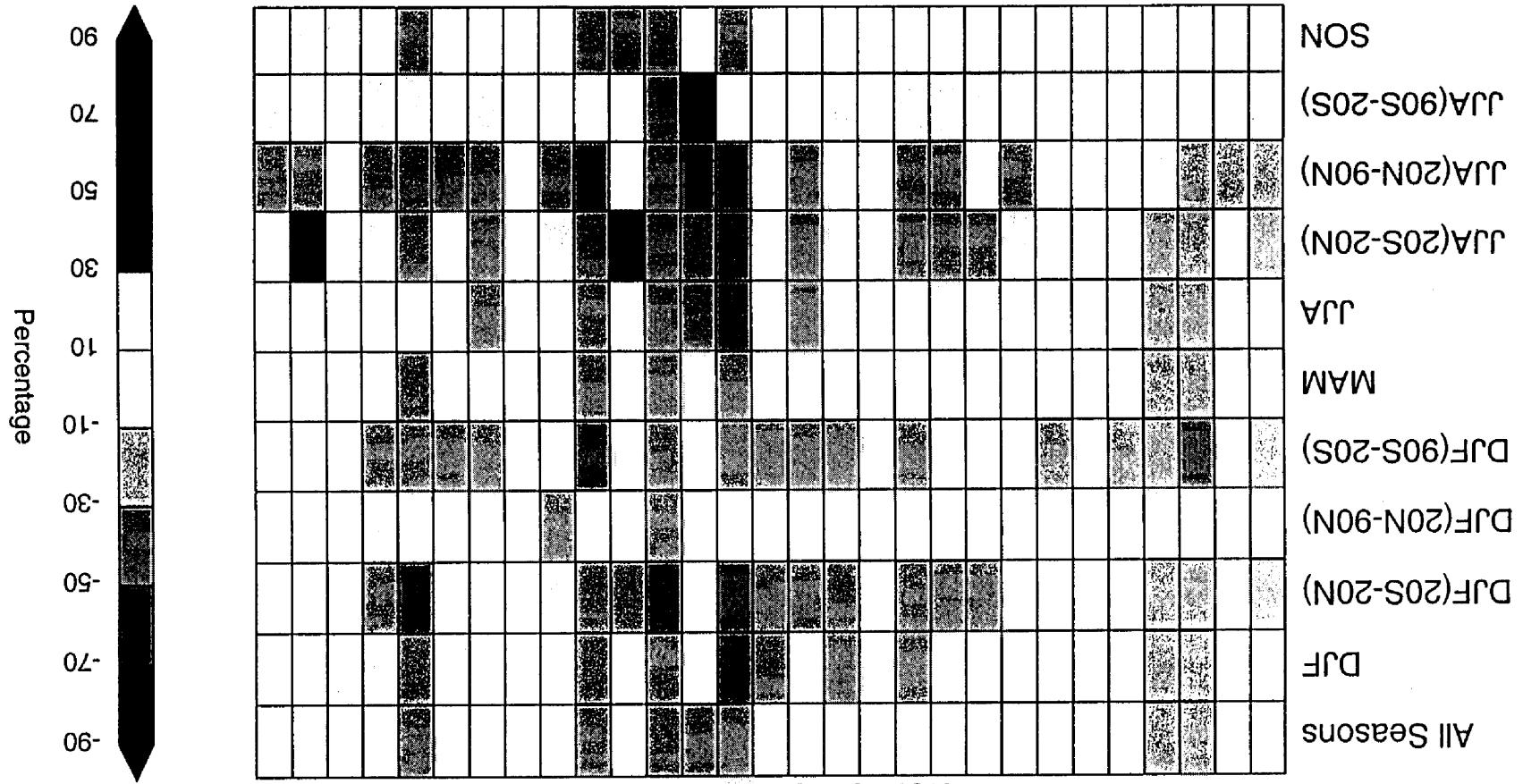
CSU\_AMIP2- ECMWF reanalysis, JJA





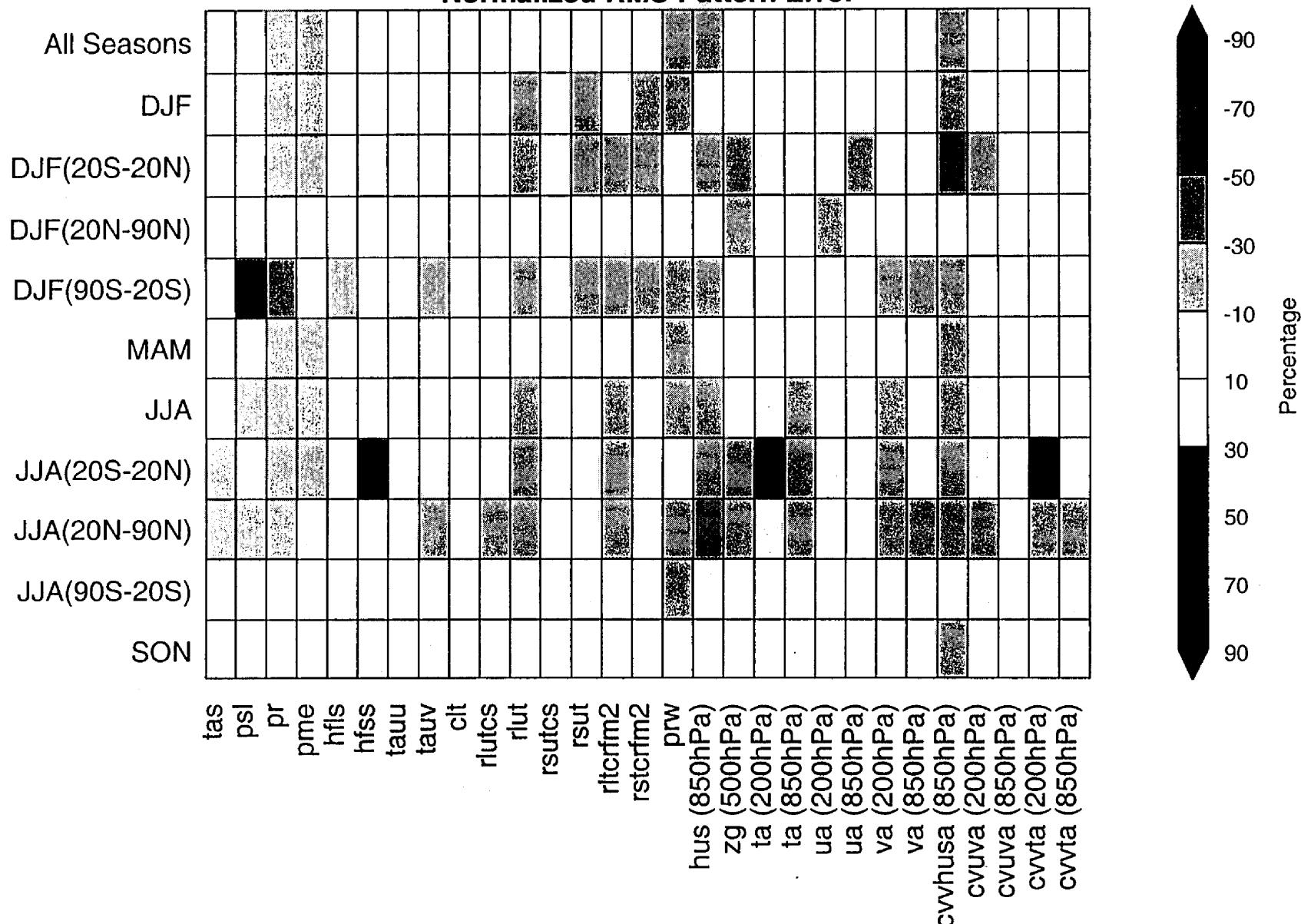


## CSU AMIP: Percentage Difference from CCM3.9.11 AMIP2



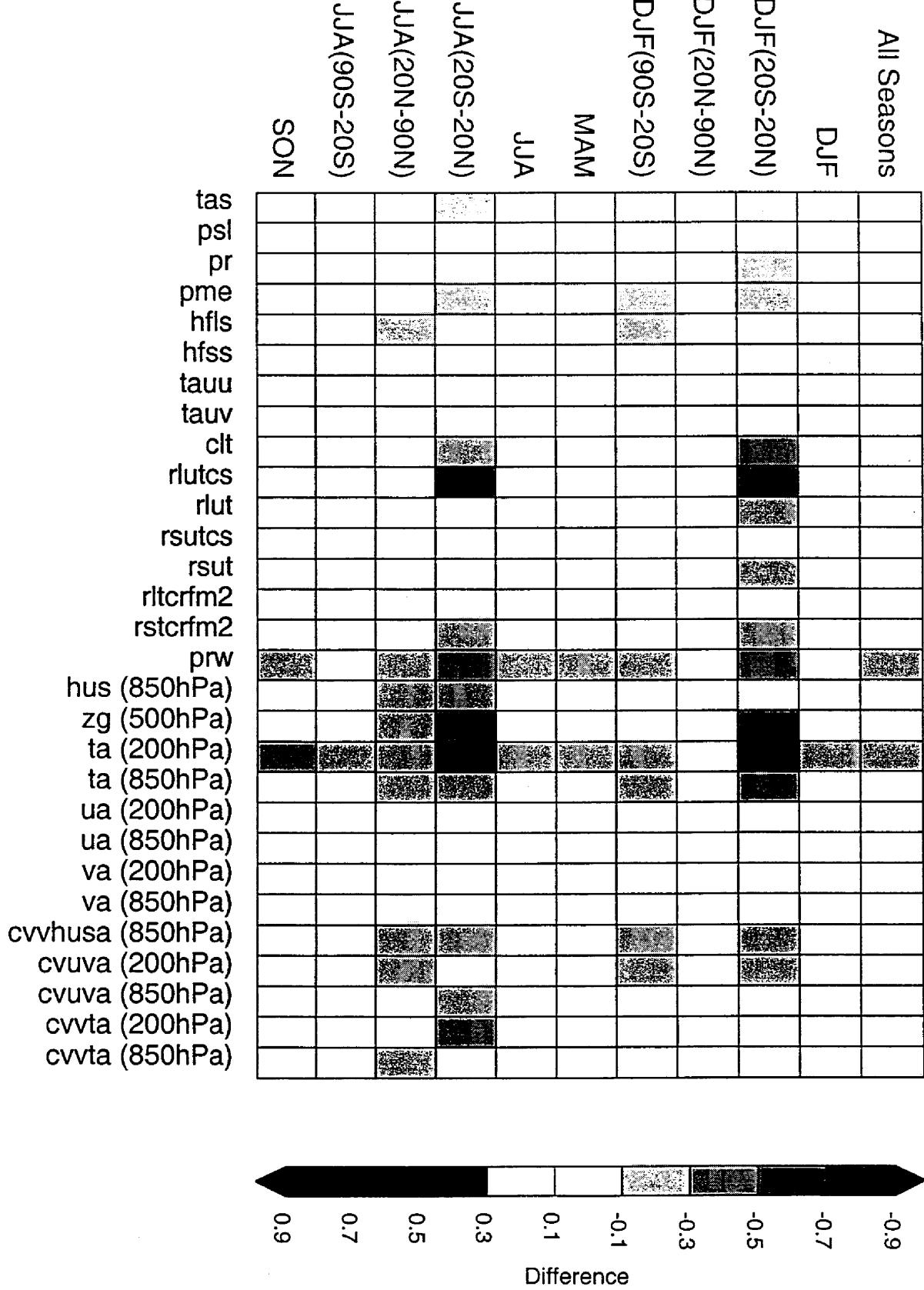
All Seasons  
DJF  
MAM  
JJA  
SON  
DJF(20S-20N)  
DJF(90S-20S)  
DJF(20N-90N)  
DJF(90S-20S)  
JJA(20N-90N)  
JJA(90S-20S)  
JJA  
MAM  
DJF  
SON

## CSU\_AMIP: Percentage Difference from CCM3.9.11 AMIP2 Normalized RMS Pattern Error



# CSU\_AMIP: Absolute Difference from CCM3.9.11 AMIP2

PCMDI  
Nov 30, 2000



# **TRIG\_AMIP**

- CCM 3.10 using Zhang-McFarlane convection with physical triggers
- T42, 30 levels
- AMIP2 run
- Contact: Phil Rasch, NCAR,  
[pjr@ucar.edu](mailto:pjr@ucar.edu)

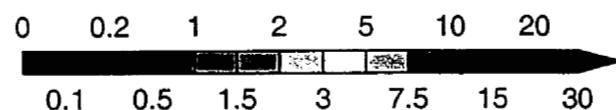
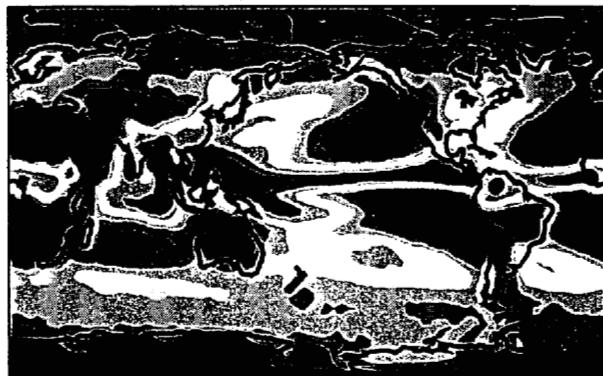
# TRIG AMIP

Total precipitation rate (mm/day)

Observed (CPC, Xie-Arkin), DJF



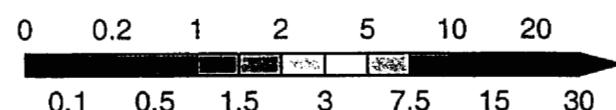
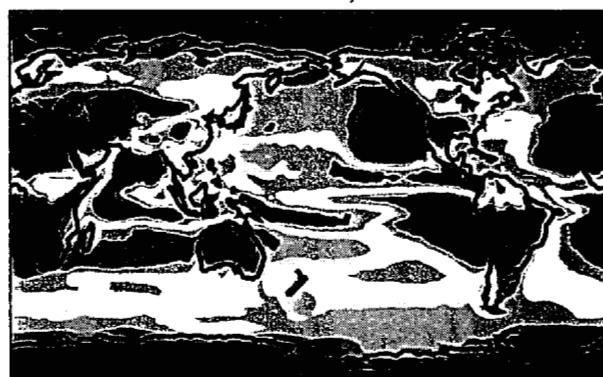
Observed (CPC, Xie-Arkin), JJA



TRIG AMIP, DJF



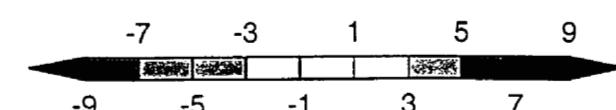
TRIG AMIP, JJA



TRIG AMIP - Observed (CPC, Xie-Arkin), DJF



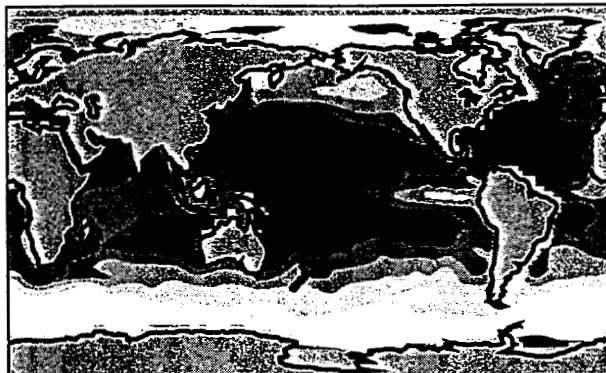
TRIG AMIP - Observed (CPC, Xie-Arkin), JJA



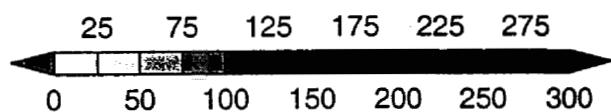
# TRIG AMIP

Heat flux latent surface ( $\text{W/m}^2$ )

Observed (COADS), DJF



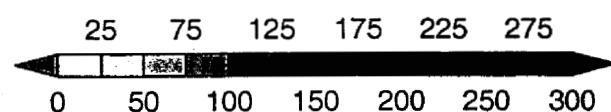
Observed (COADS), JJA



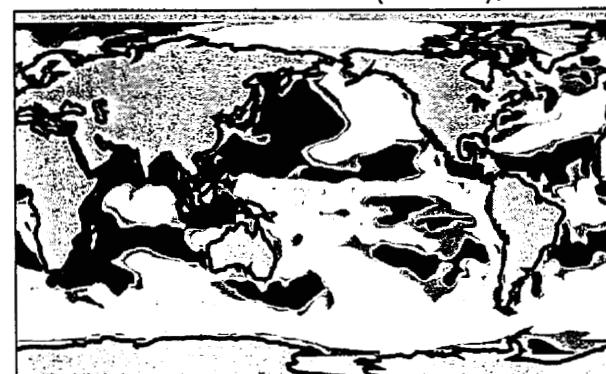
TRIG AMIP, DJF



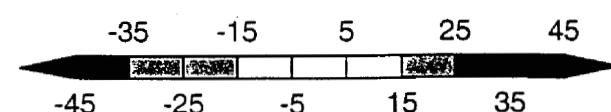
TRIG AMIP, JJA



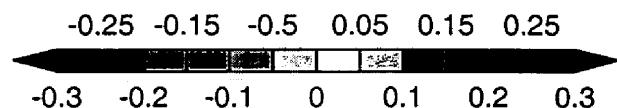
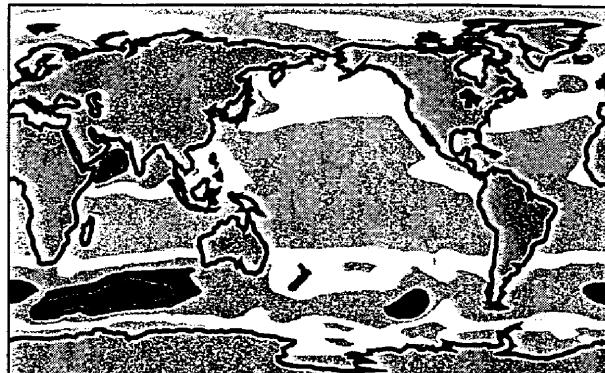
TRIG AMIP - Observed (COADS), DJF



TRIG AMIP - Observed (COADS), JJA



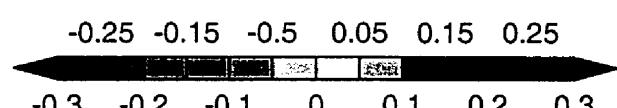
Eastward surface wind stress (positive for eastward wind) ( $\text{N/m}^2$ )  
UWMCOADS, DJF



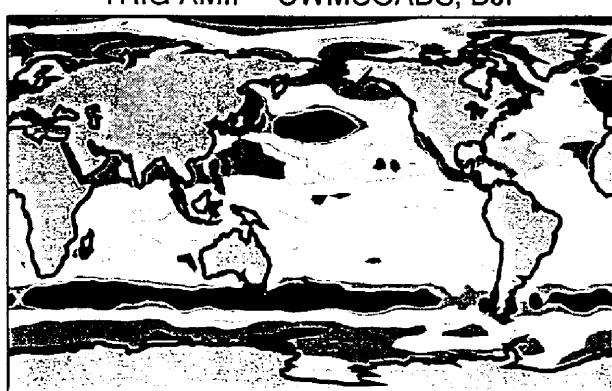
TRIG AMIP, DJF



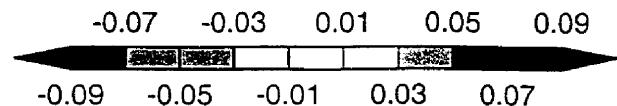
TRIG AMIP, JJA



TRIG AMIP - UWMCOADS, DJF



TRIG AMIP - UWMCOADS, JJA



# TRIG AMIP

LW radiation TOA (OLR) ( $\text{W/m}^2$ )

Observed (ERBE), DJF



Observed (ERBE), JJA



120 160 200 240 280 320

100 140 180 220 260 300 340

TRIG AMIP, DJF



TRIG AMIP, JJA



120 160 200 240 280 320

100 140 180 220 260 300 340

TRIG AMIP - Observed (ERBE), DJF



TRIG AMIP - Observed (ERBE), JJA



-35 -15 5 25 45

-45 -25 -5 15 35

# TRIG AMIP

Total Cloud Amount (%)

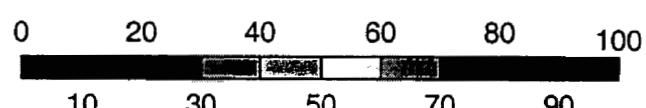
Observed (ISCCP), DJF



Observed (ISCCP), JJA



TRIG AMIP, DJF



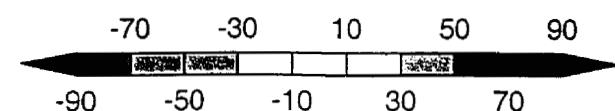
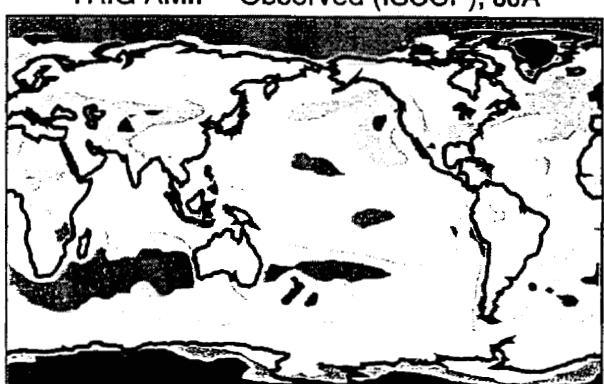
TRIG AMIP, JJA



TRIG AMIP - Observed (ISCCP), DJF



TRIG AMIP - Observed (ISCCP), JJA



# TRIG AMIP

Sea Level Pressure (hPa)

Observed (ECMWF Reanalysis), DJF



Observed (ECMWF Reanalysis), JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

TRIG AMIP, DJF



TRIG AMIP, JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

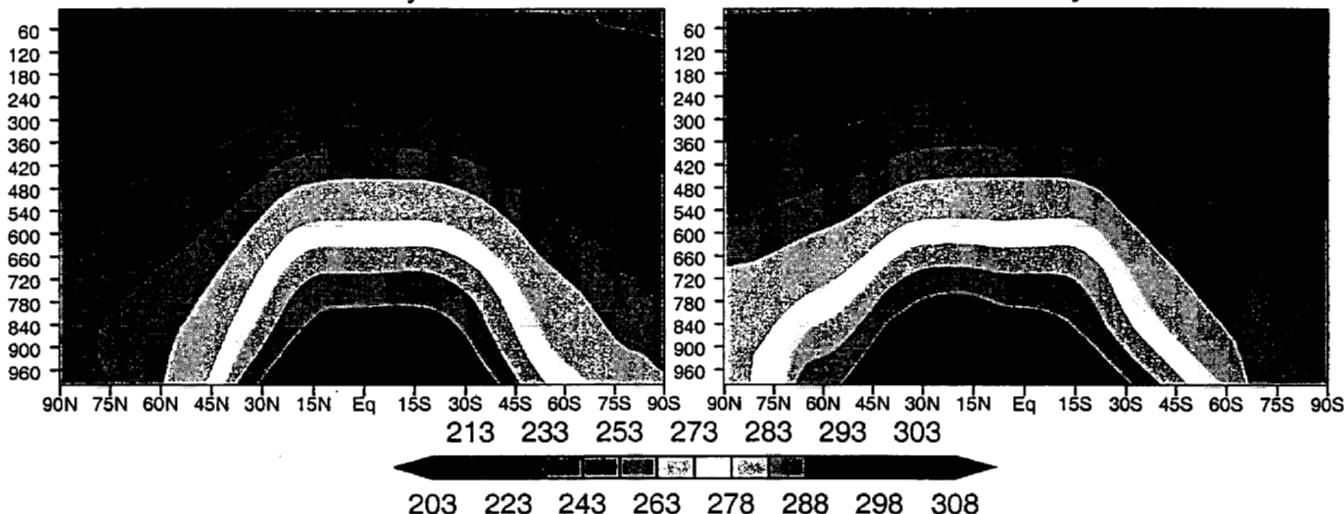
TRIG AMIP - Observed (ECMWF Reanalysis), DJF TRIG AMIP - Observed (ECMWF Reanalysis), JJA



-7 -3 1 5 9

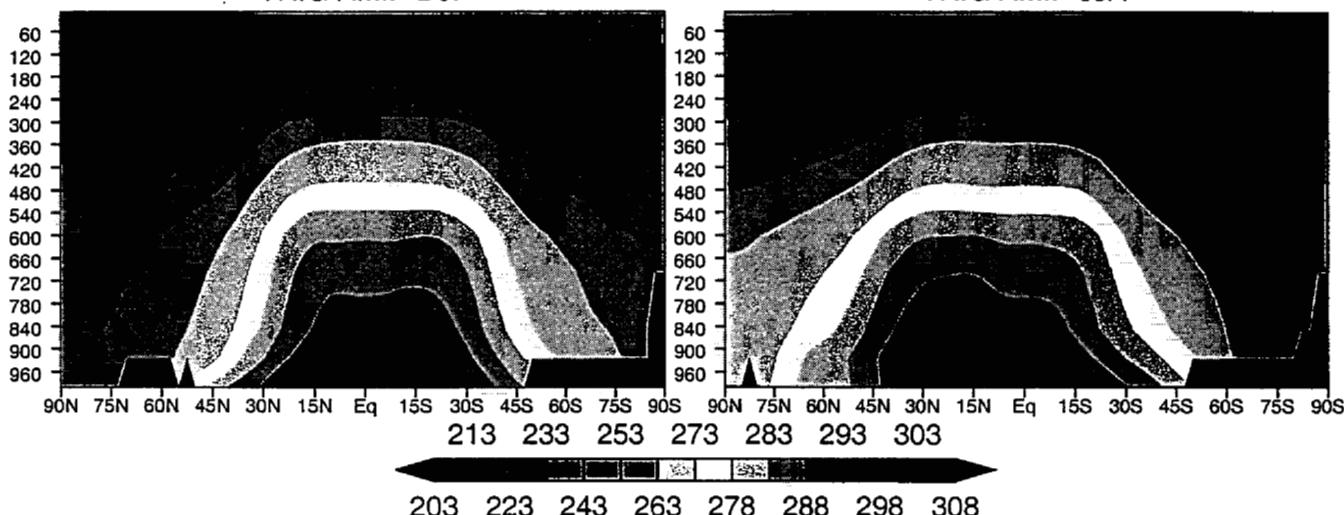
-9 -5 -1 3 7

Air Temperature  
ECMWF reanalysis DJF



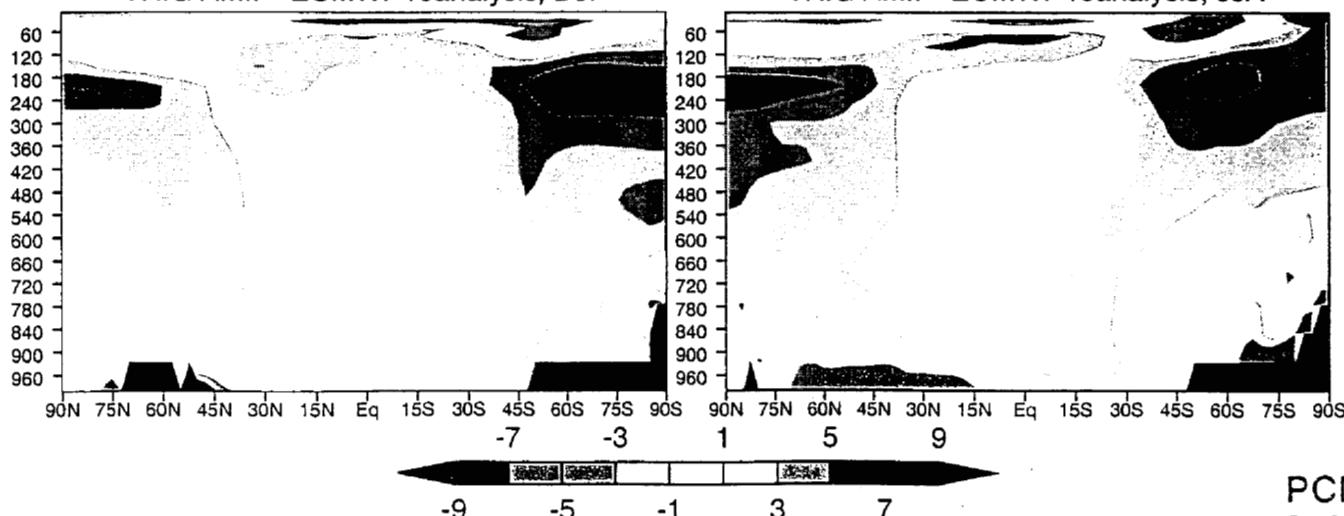
ECMWF reanalysis JJA

TRIG AMIP DJF



TRIG AMIP JJA

TRIG AMIP- ECMWF reanalysis, DJF

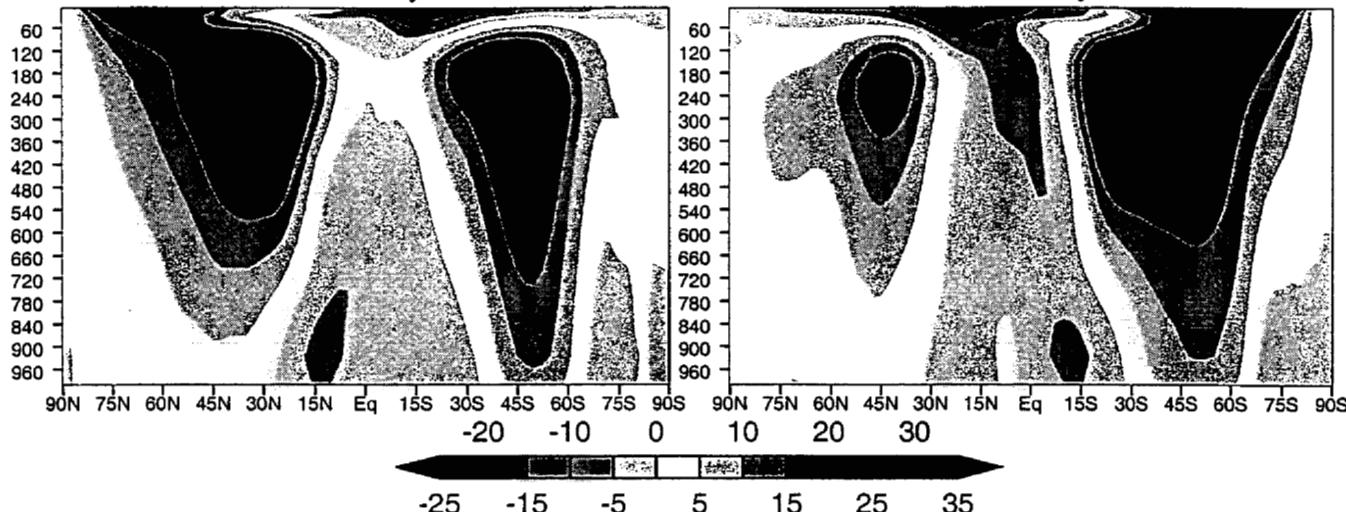


TRIG AMIP- ECMWF reanalysis, JJA

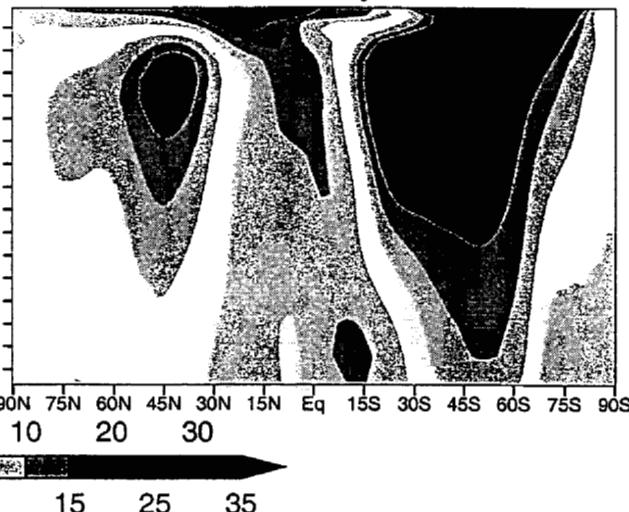
# TRIG AMIP

Eastward wind

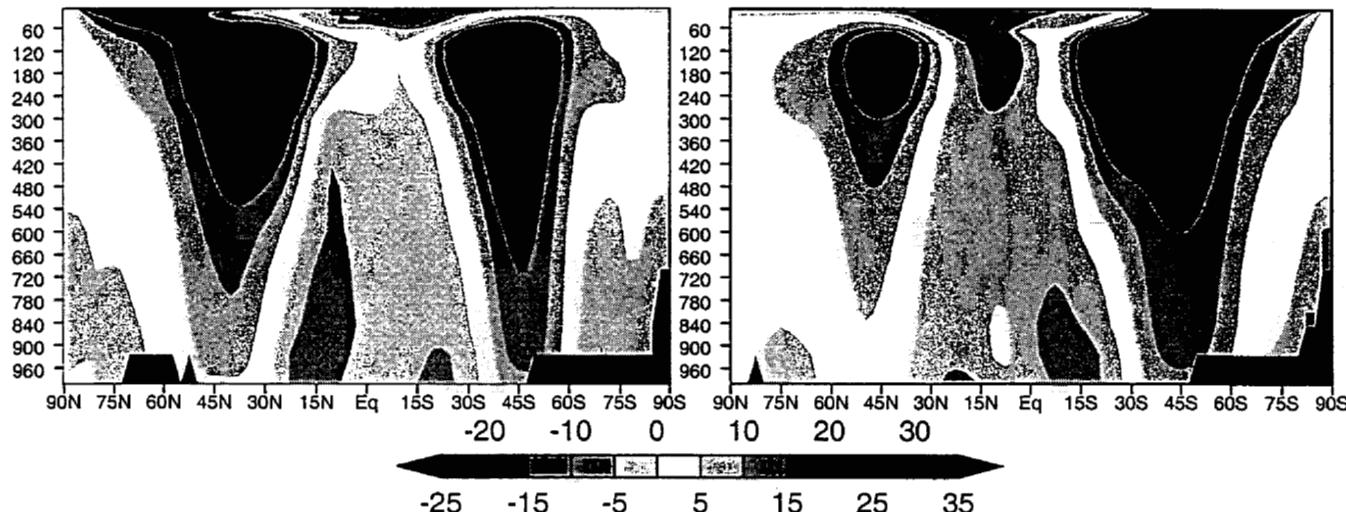
ECMWF reanalysis DJF



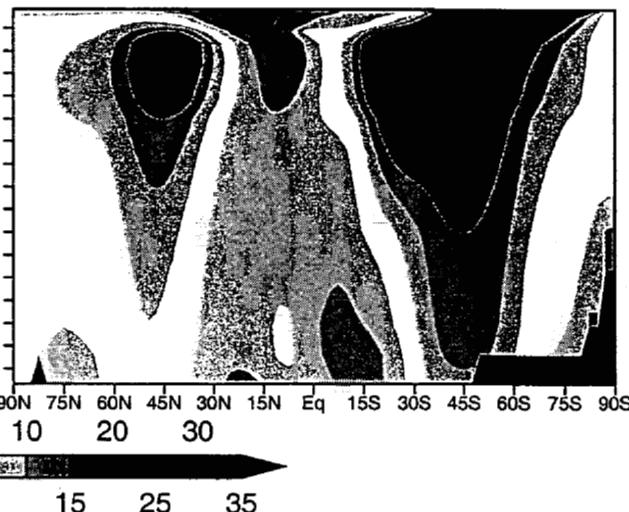
ECMWF reanalysis JJA



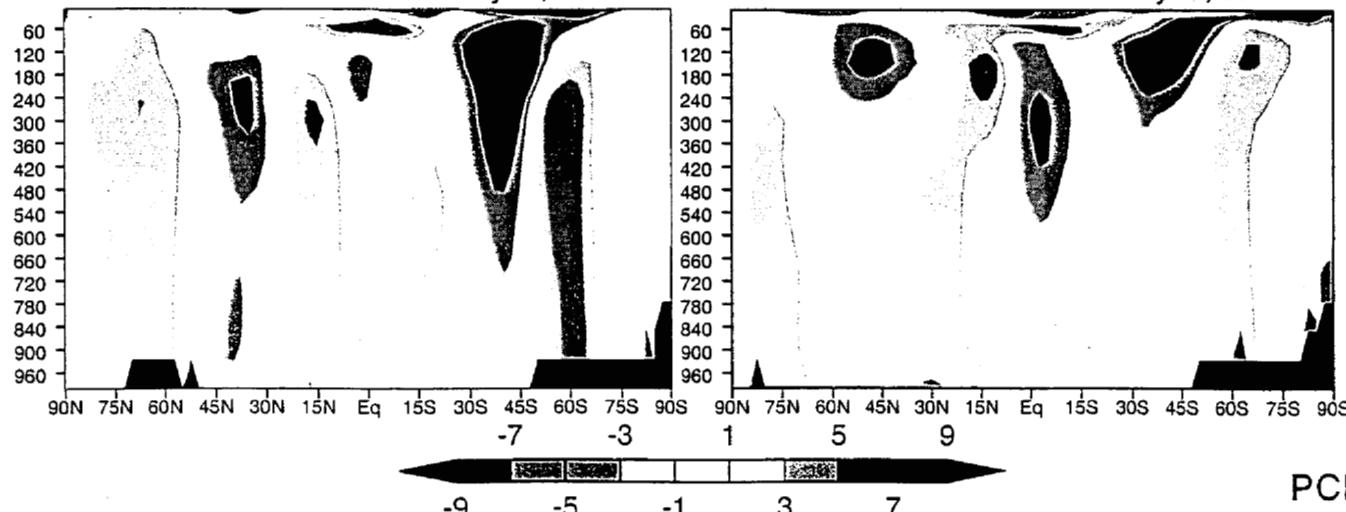
TRIG AMIP DJF



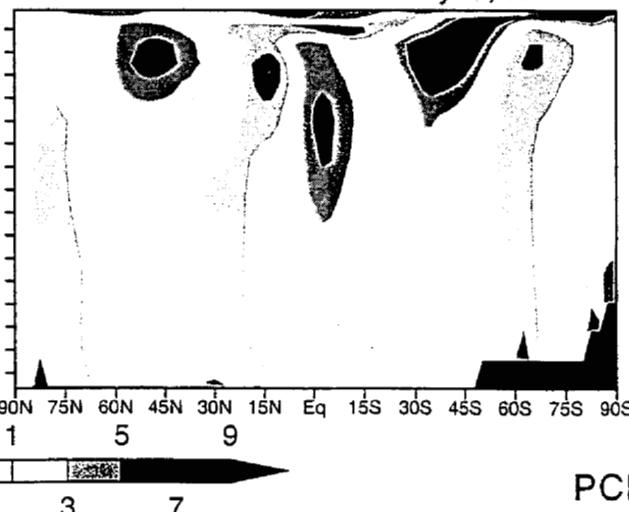
TRIG AMIP JJA



TRIG AMIP- ECMWF reanalysis, DJF



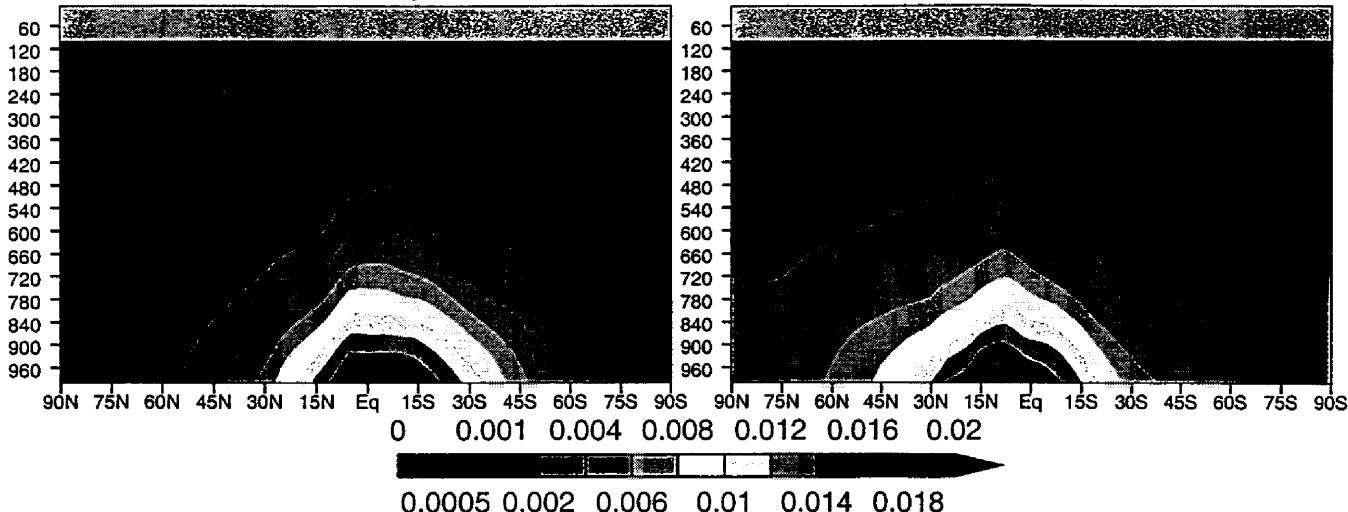
TRIG AMIP- ECMWF reanalysis, JJA



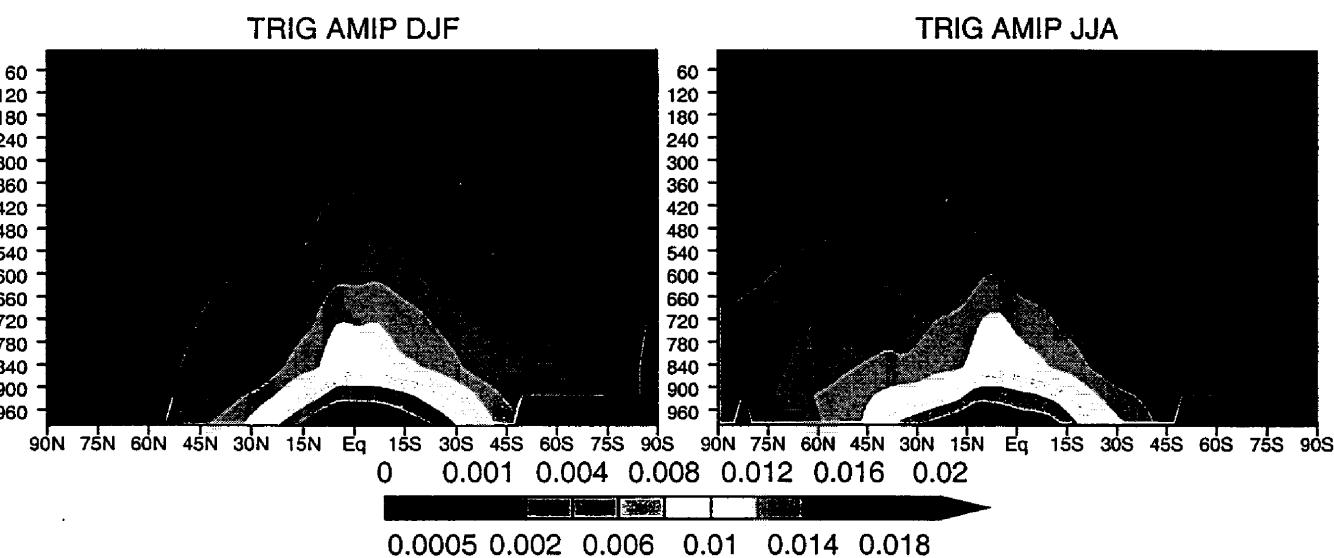
# TRIG AMIP

Specific humidity

ECMWF reanalysis DJF

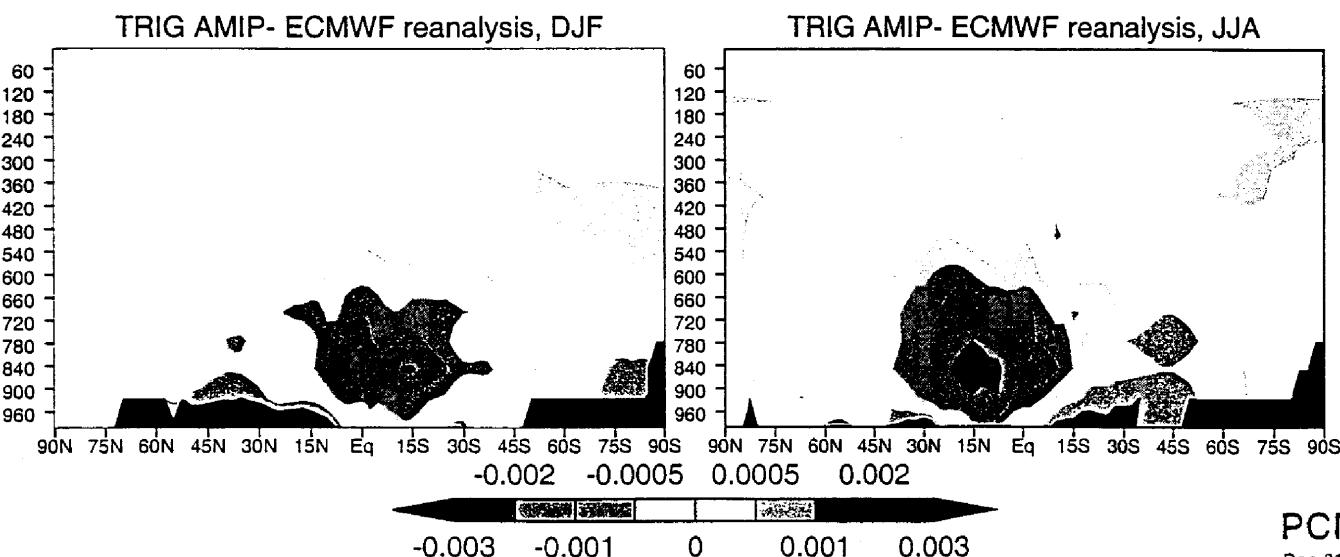


ECMWF reanalysis JJA



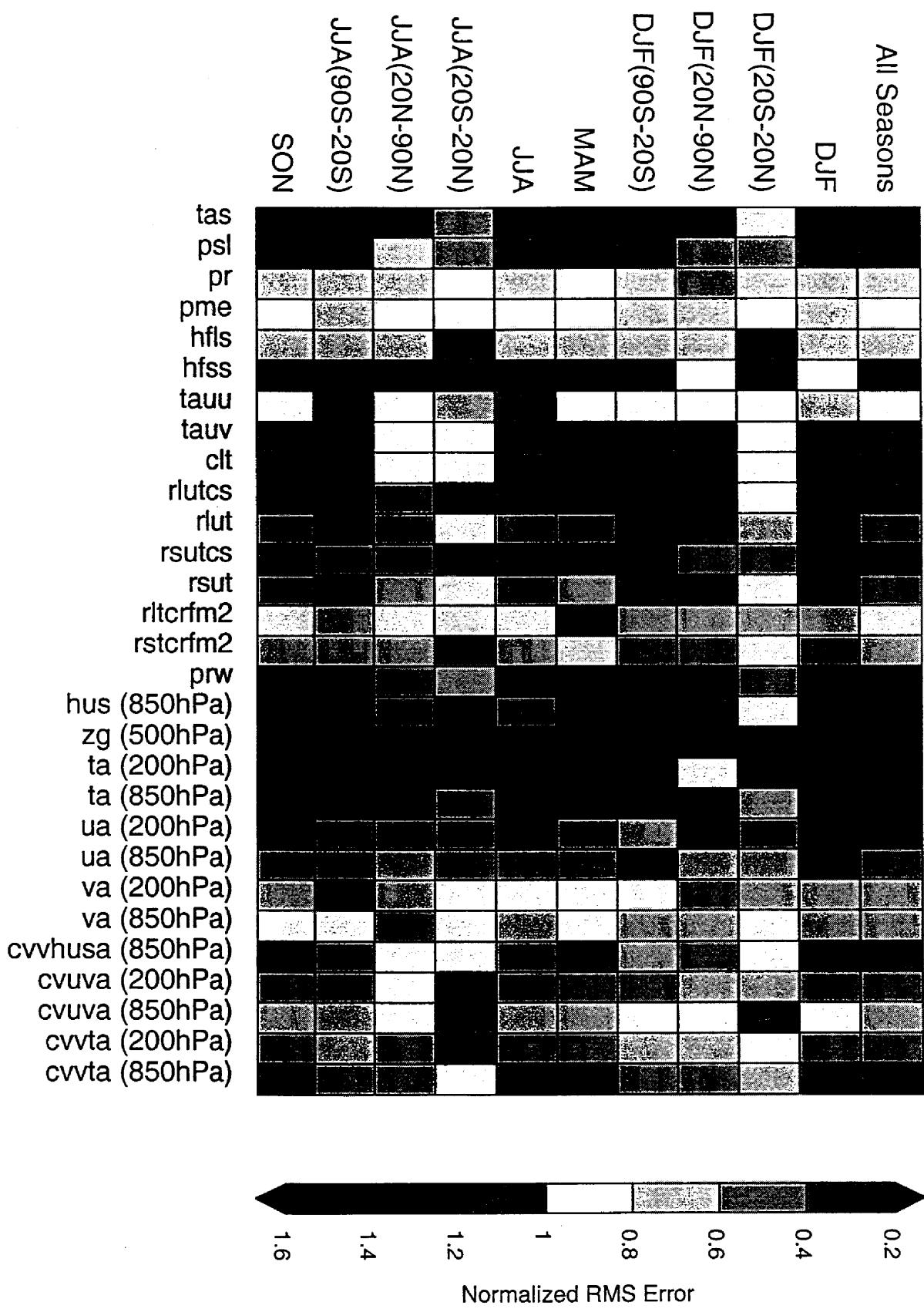
TRIG AMIP DJF

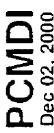
TRIG AMIP JJA



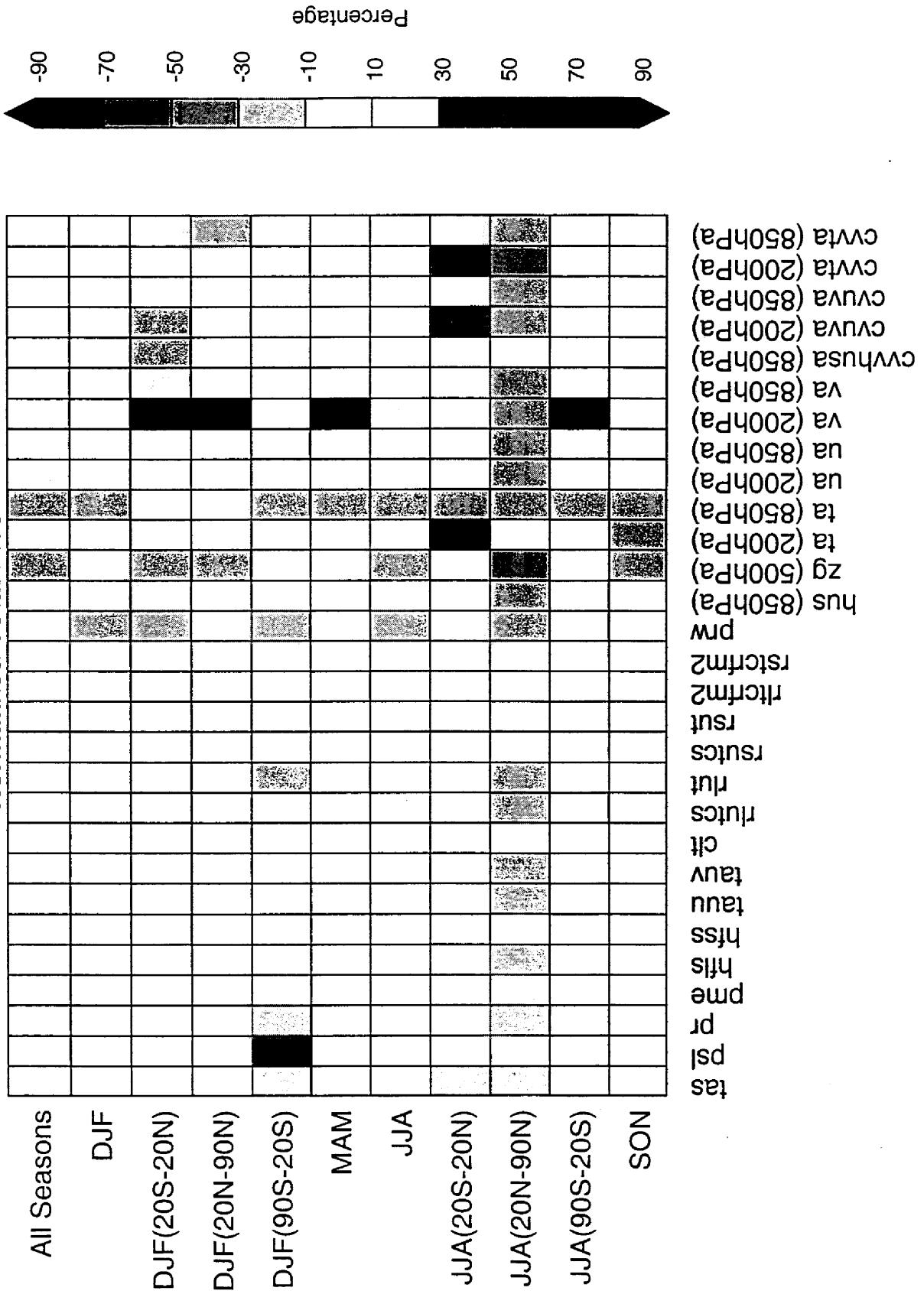
TRIG AMIP- ECMWF reanalysis, JJA

# TRIG AMIP Normalized Total Error

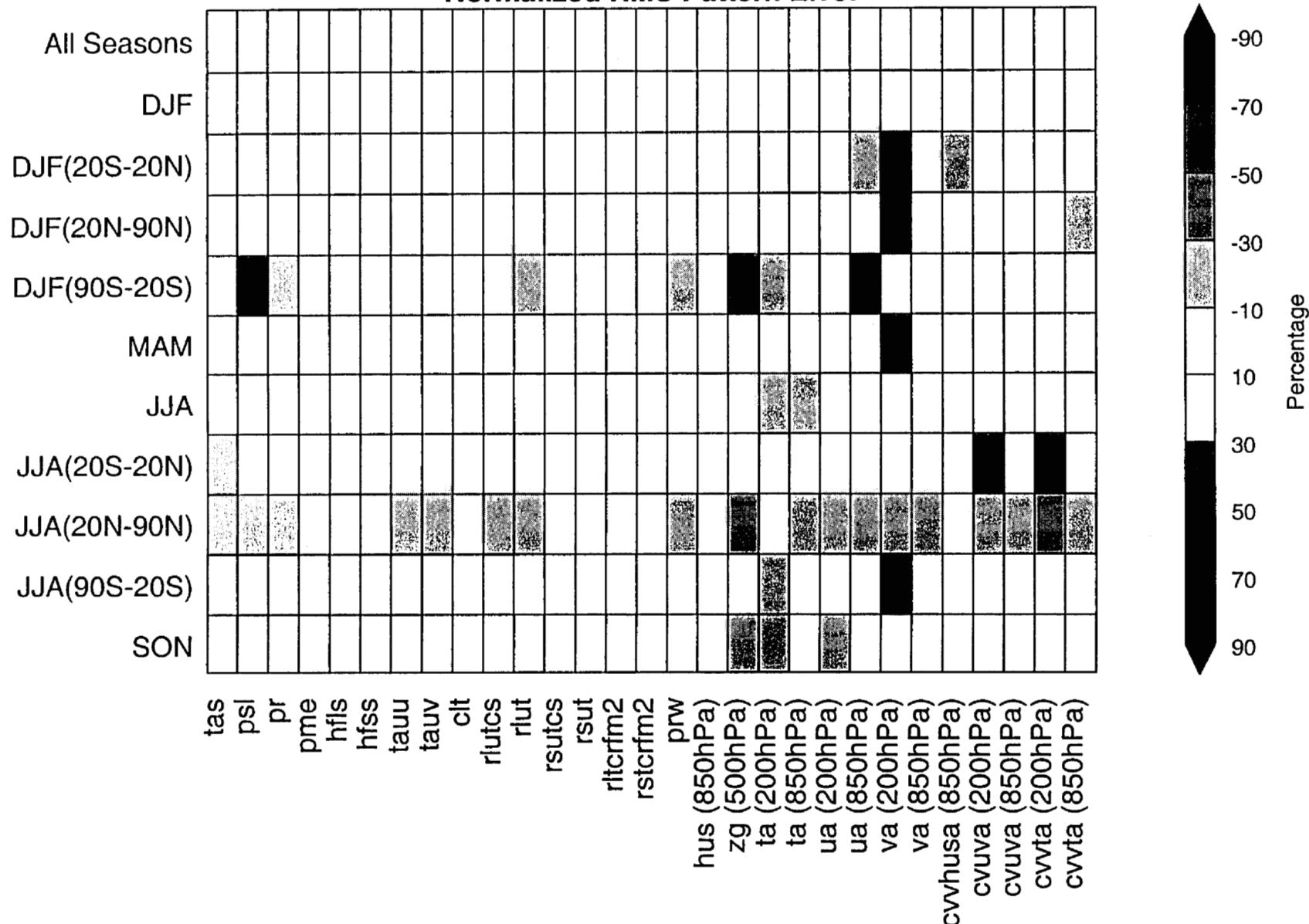




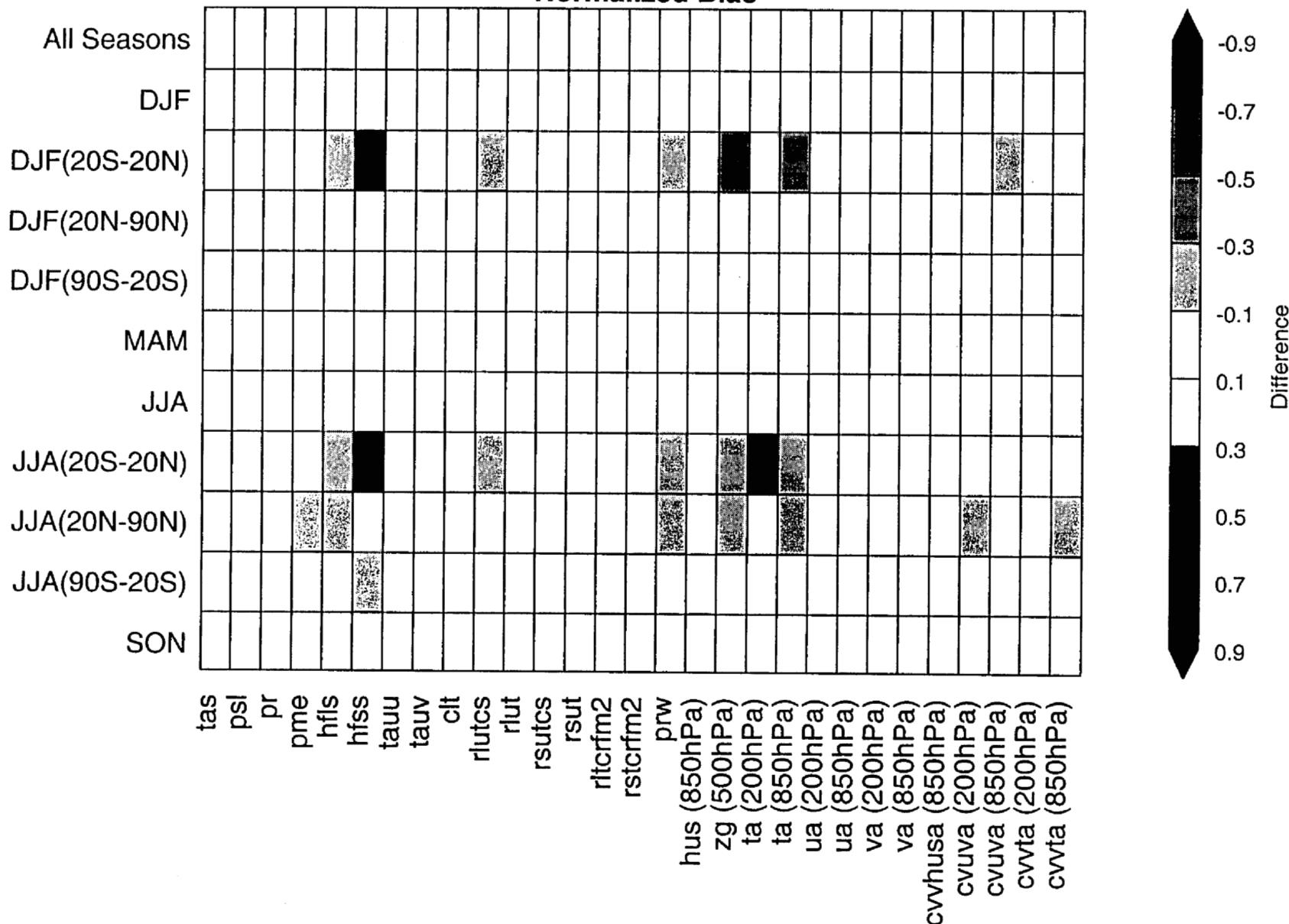
## TRIG\_AMIP: Percentage Difference from CCM3.9.11 AMIP2 Normalized Total Error



## TRIG\_AMIP: Percentage Difference from CCM3.9.11 AMIP2 Normalized RMS Pattern Error



## TRIG\_AMIP: Absolute Difference from CCM3.9.11 AMIP2 Normalized Bias



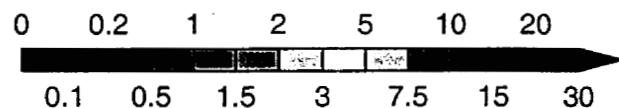
# ZHANG

- Zhang-McFarlane convection with modified closure
- T42, 30 levels
- 5 year climatology run
- no AMIP2 run
- Contact: Guang Zhang, Scripps Institute of Oceanography,  
[gzhang@ucsd.edu](mailto:gzhang@ucsd.edu)

## Total precipitation rate (mm/day)

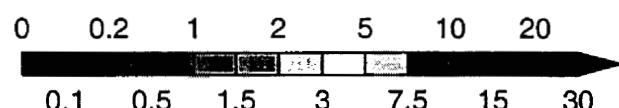
Observed (CPC, Xie-Arkin), DJF

Observed (CPC, Xie-Arkin), JJA



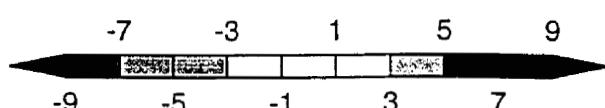
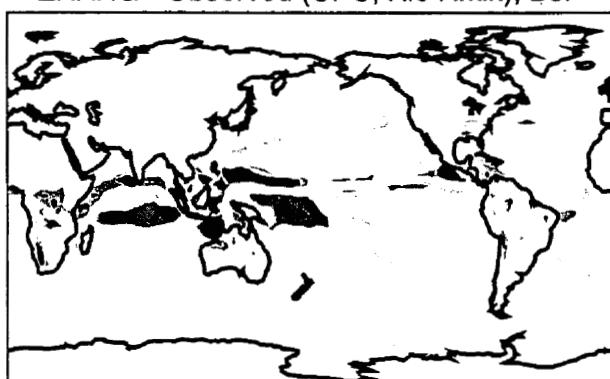
ZHANG, DJF

ZHANG, JJA



ZHANG - Observed (CPC, Xie-Arkin), DJF

ZHANG - Observed (CPC, Xie-Arkin), JJA

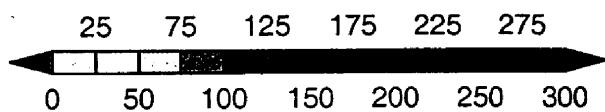


Heat flux latent surface ( $\text{W/m}^2$ )

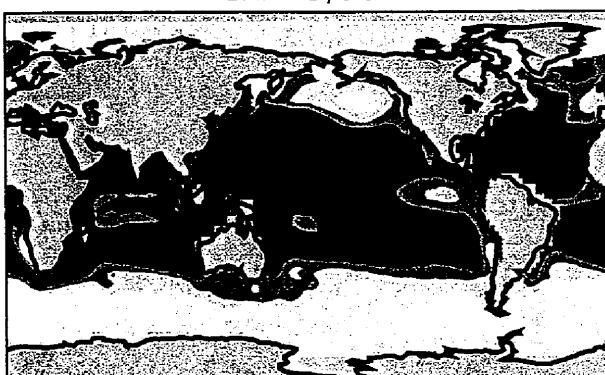
Observed (COADS), DJF



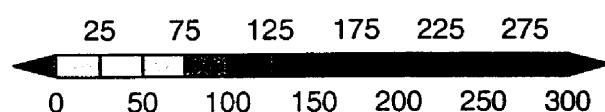
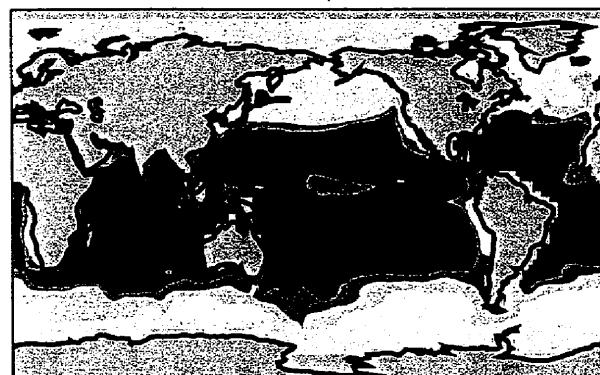
Observed (COADS), JJA



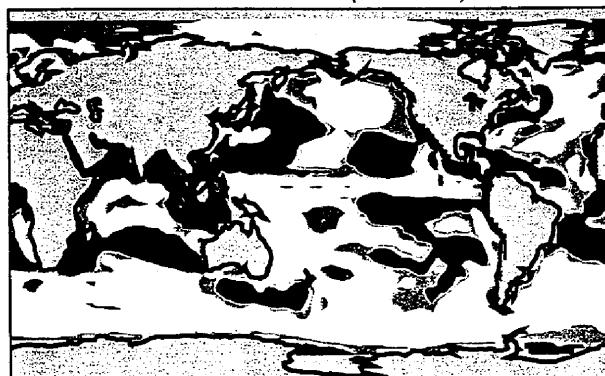
ZHANG, DJF



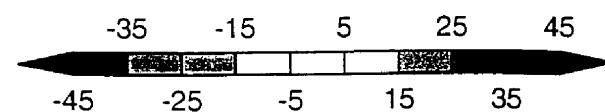
ZHANG, JJA



ZHANG - Observed (COADS), DJF

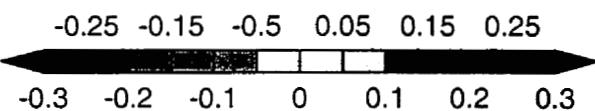
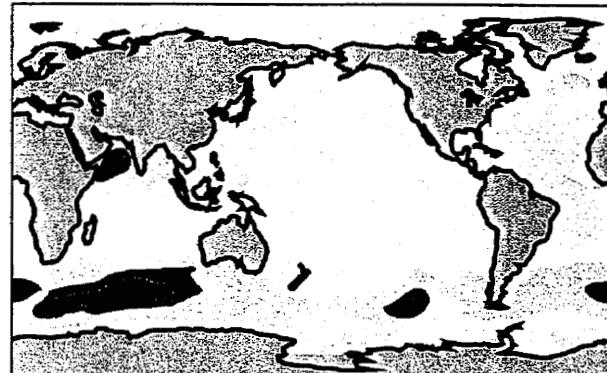
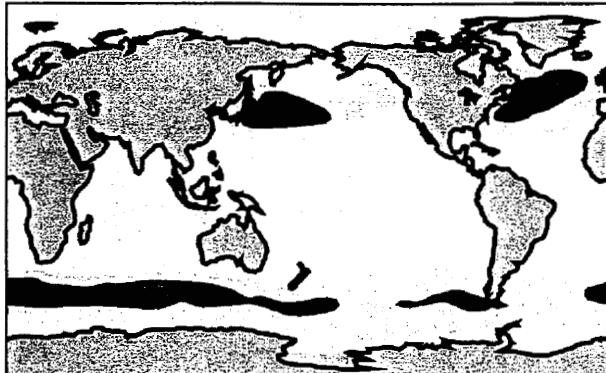


ZHANG - Observed (COADS), JJA



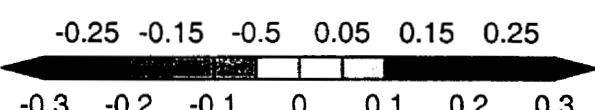
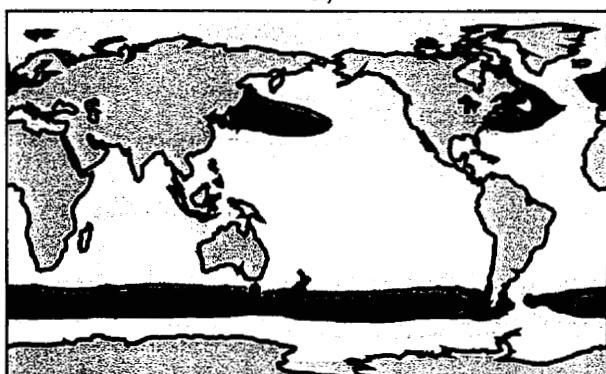
ZHANG

Eastward surface wind stress (positive for eastward wind) ( $N/m^2$ )  
UWMCOADS, DJF      UWMCOADS, JJA



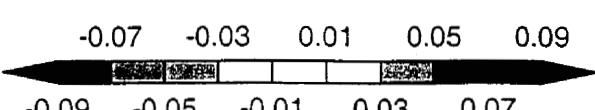
ZHANG, DJF

ZHANG, JJA



ZHANG - UWMCOADS, DJF

ZHANG - UWMCOADS, JJA



LW radiation TOA (OLR) ( $\text{W/m}^2$ )

Observed (ERBE), DJF



Observed (ERBE), JJA



120 160 200 240 280 320

100 140 180 220 260 300 340

ZHANG, DJF



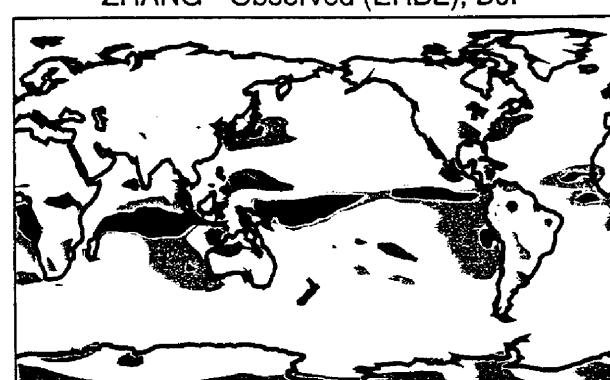
ZHANG, JJA



120 160 200 240 280 320

100 140 180 220 260 300 340

ZHANG - Observed (ERBE), DJF



ZHANG - Observed (ERBE), JJA

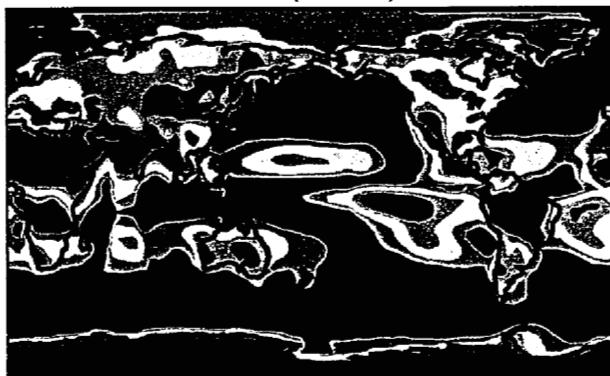


-35 -15 5 25 45

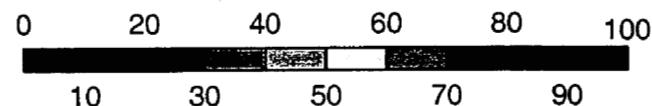
-45 -25 -5 15 35

Total Cloud Amount (%)

Observed (ISCCP), DJF



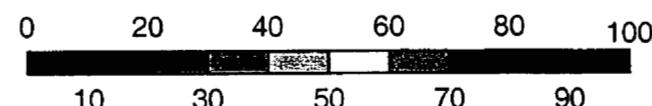
Observed (ISCCP), JJA



ZHANG, DJF



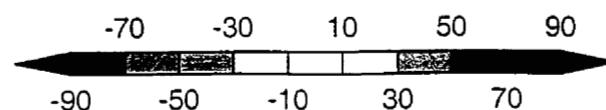
ZHANG, JJA



ZHANG - Observed (ISCCP), DJF



ZHANG - Observed (ISCCP), JJA



## Sea Level Pressure (hPa)

Observed (ECMWF Reanalysis), DJF



Observed (ECMWF Reanalysis), JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

ZHANG, DJF



ZHANG, JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

ZHANG - Observed (ECMWF Reanalysis), DJF



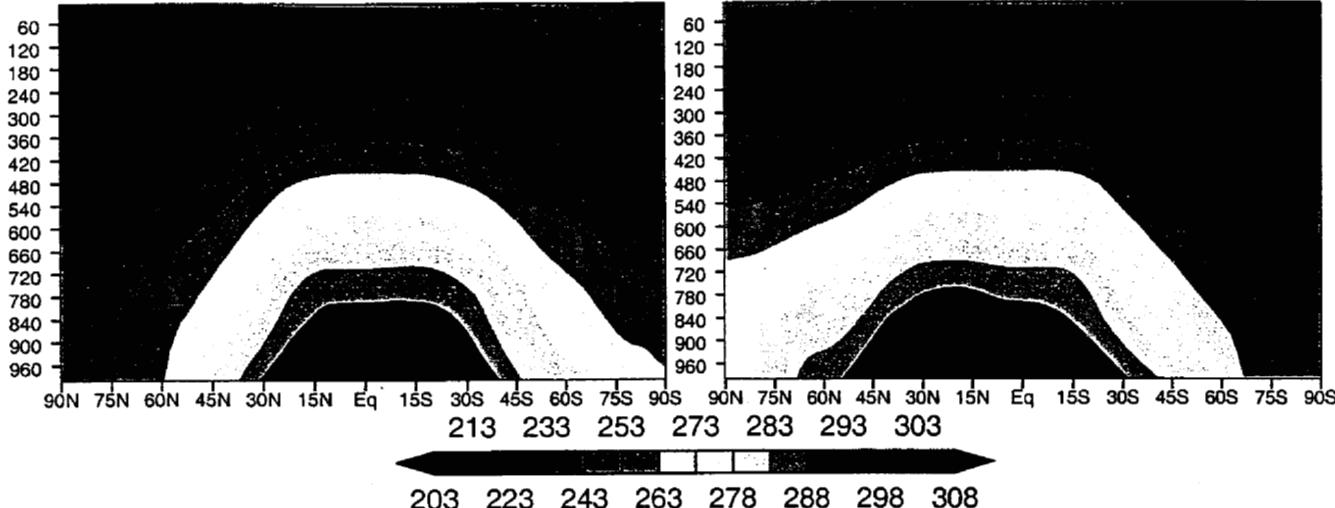
ZHANG - Observed (ECMWF Reanalysis), JJA



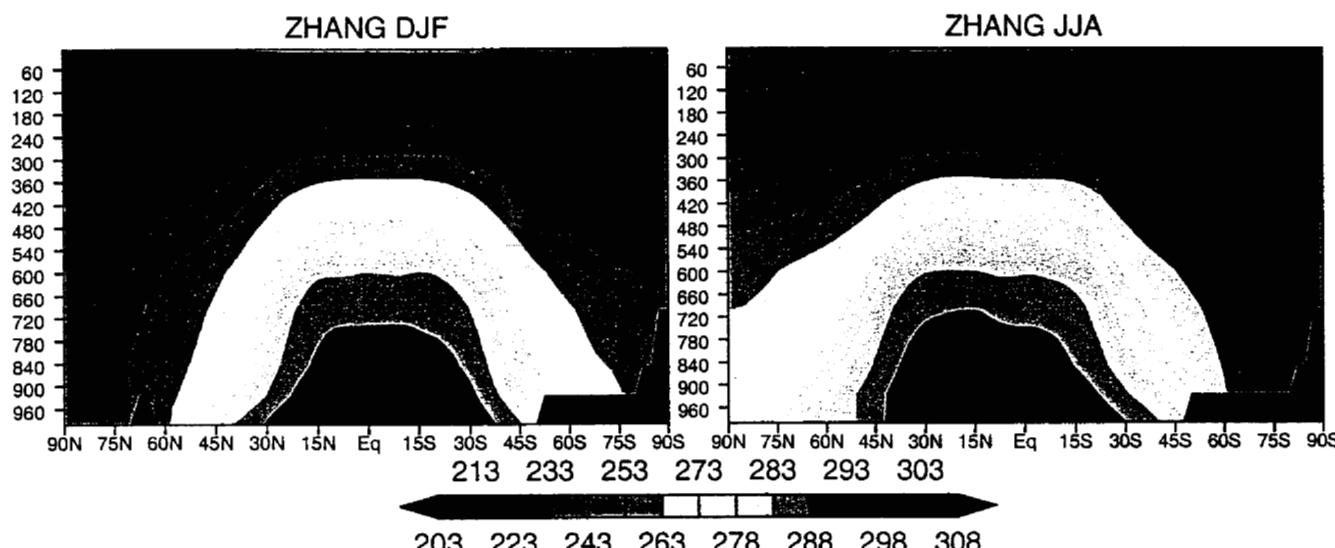
-7 -3 1 5 9  
-9 -5 -1 3 7

## Air Temperature

ECMWF reanalysis DJF



ECMWF reanalysis JJA

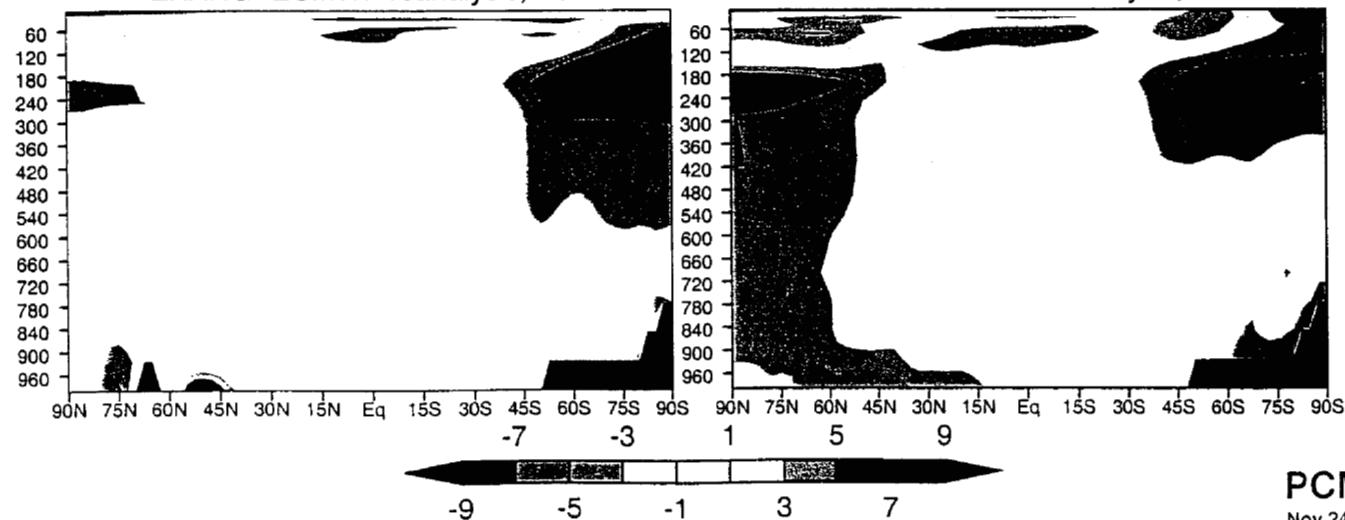


ZHANG DJF

ZHANG JJA

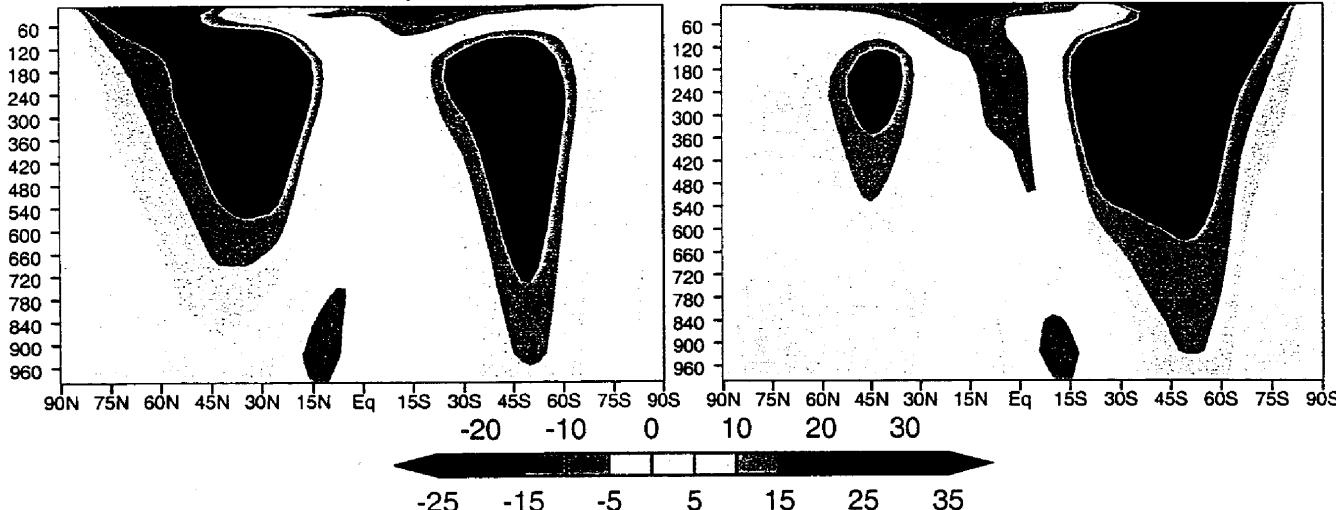
ZHANG- ECMWF reanalysis, DJF

ZHANG- ECMWF reanalysis, JJA

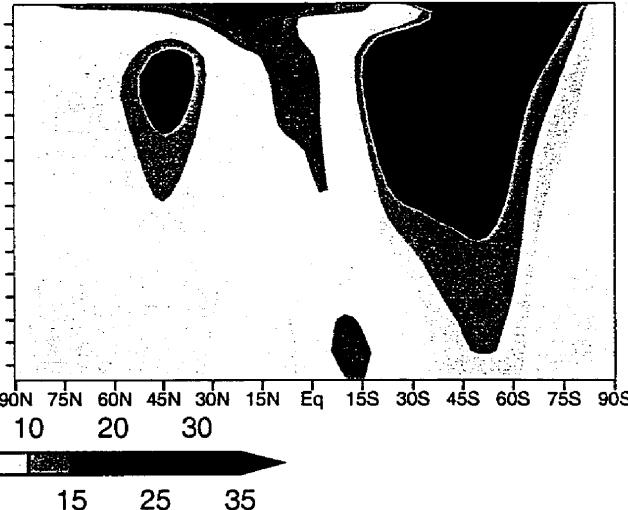


Eastward wind

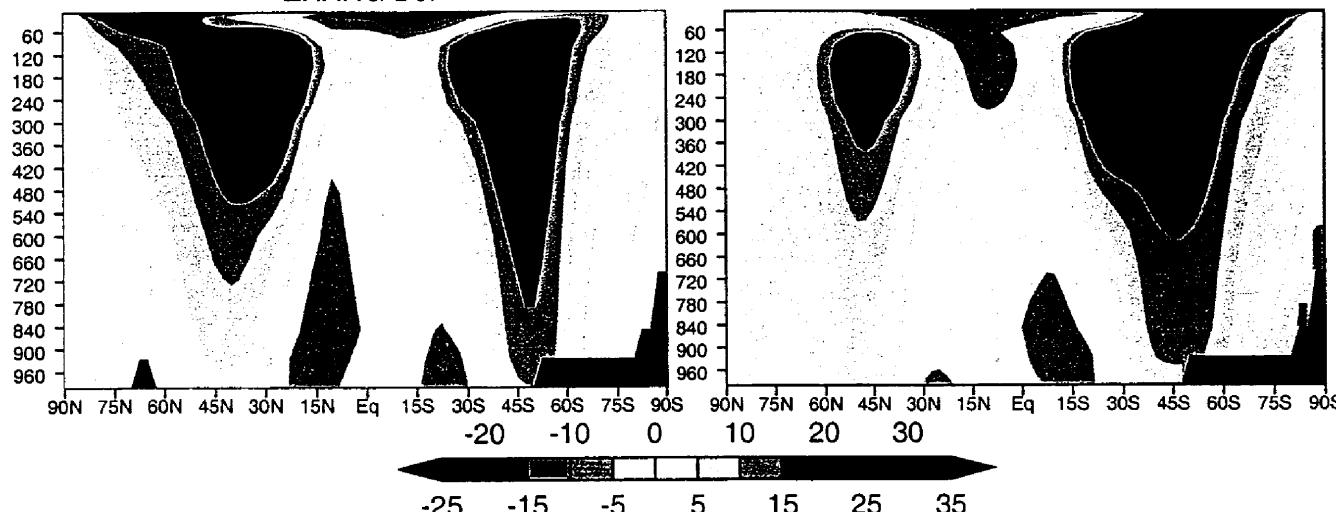
ECMWF reanalysis DJF



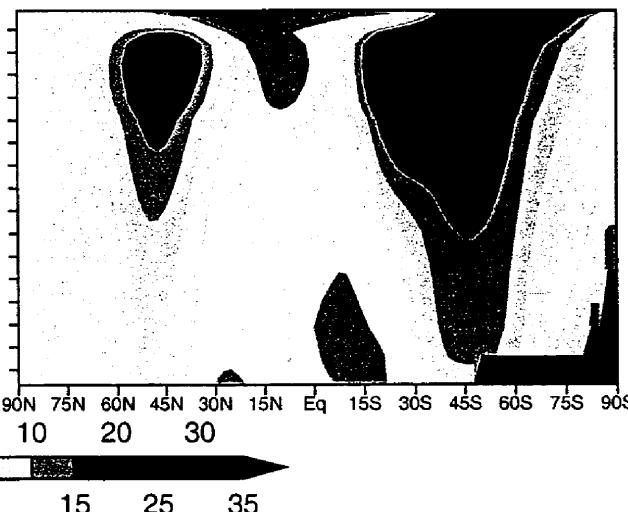
ECMWF reanalysis JJA



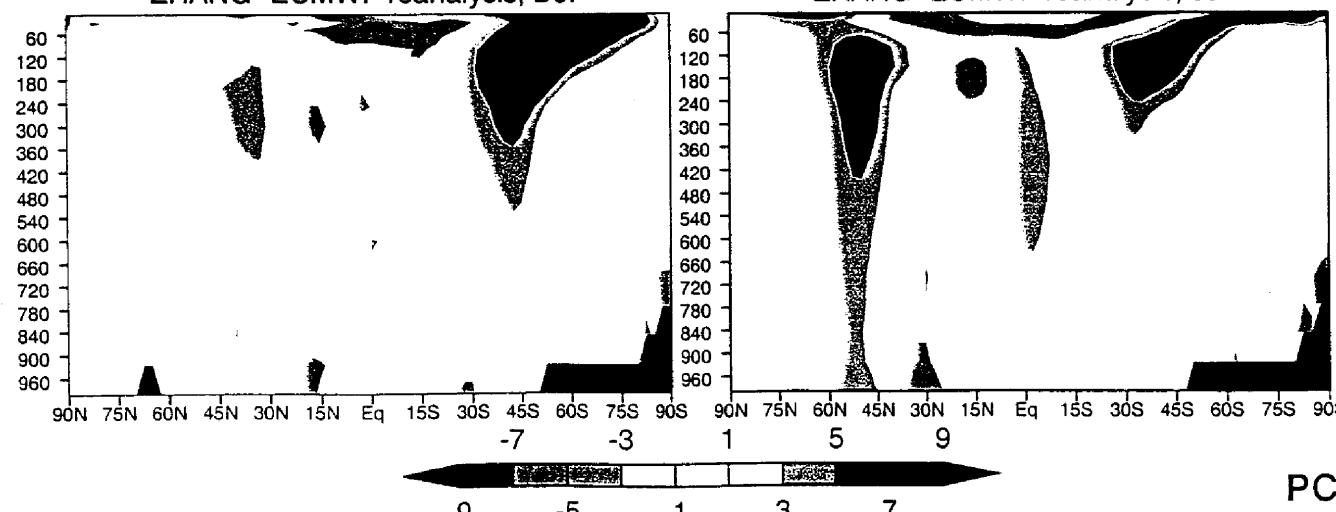
ZHANG DJF



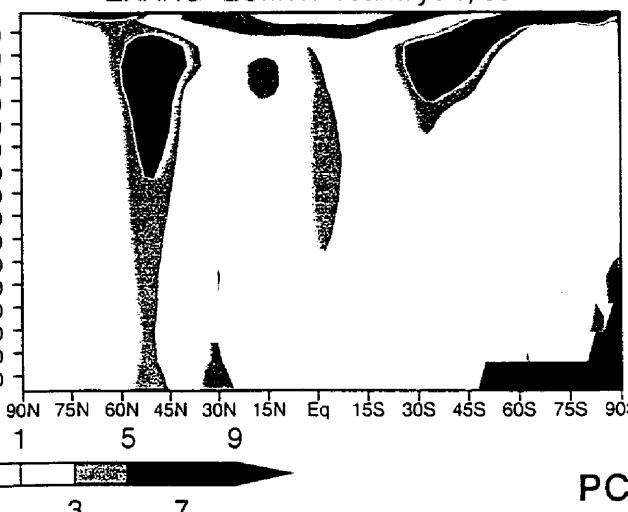
ZHANG JJA



ZHANG- ECMWF reanalysis, DJF

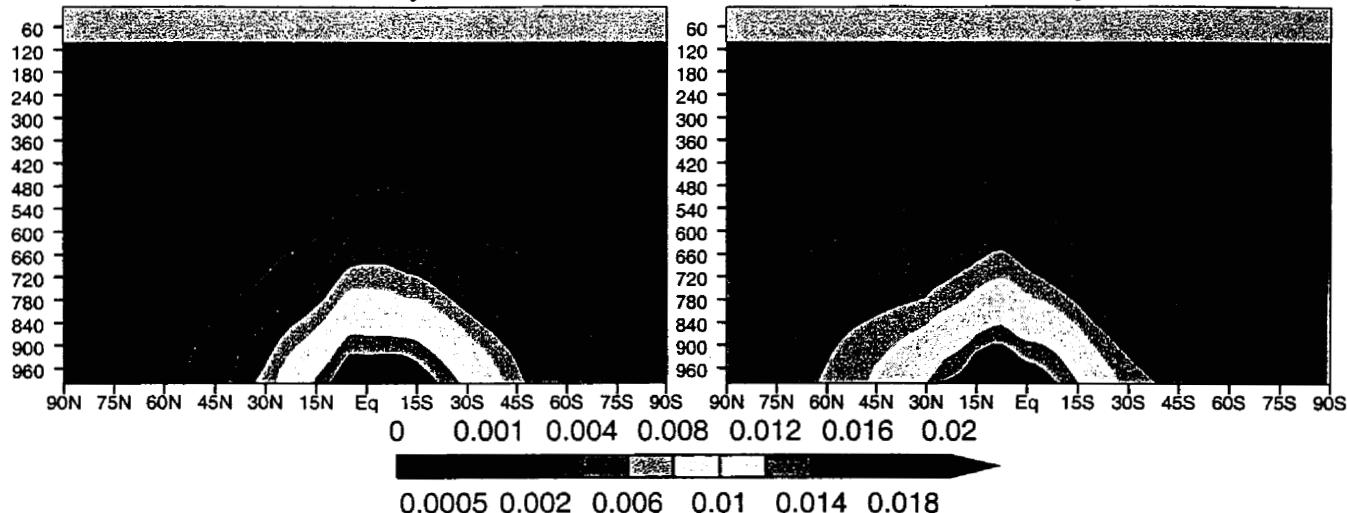


ZHANG- ECMWF reanalysis, JJA

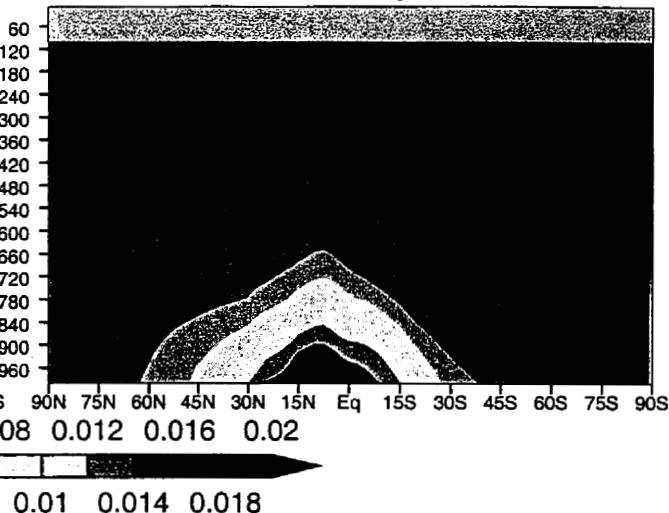


## Specific humidity

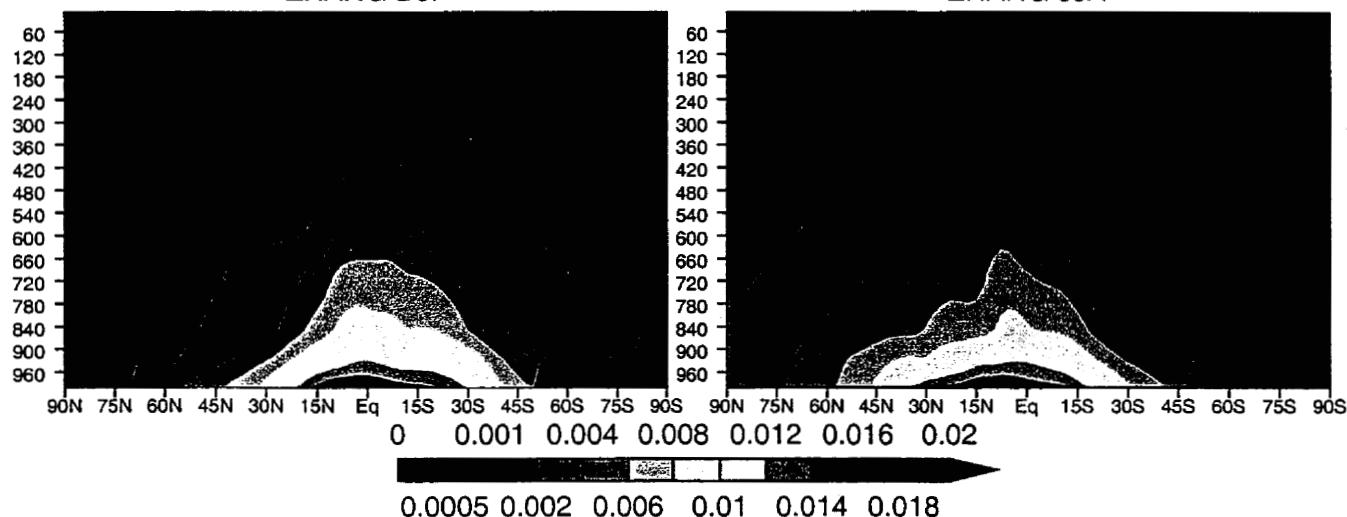
ECMWF reanalysis DJF



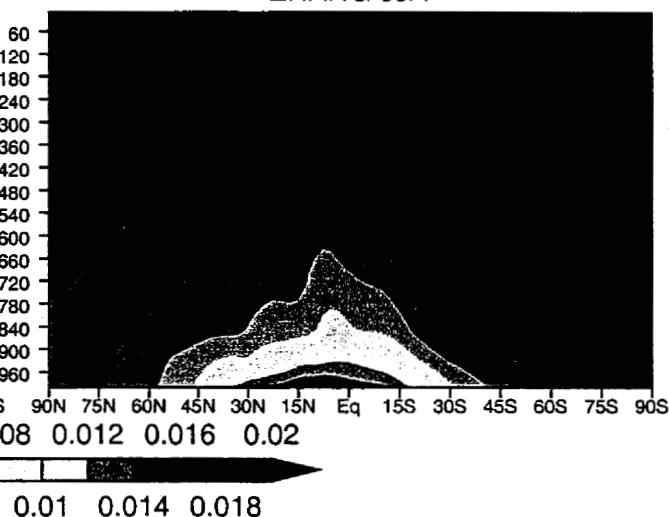
ECMWF reanalysis JJA



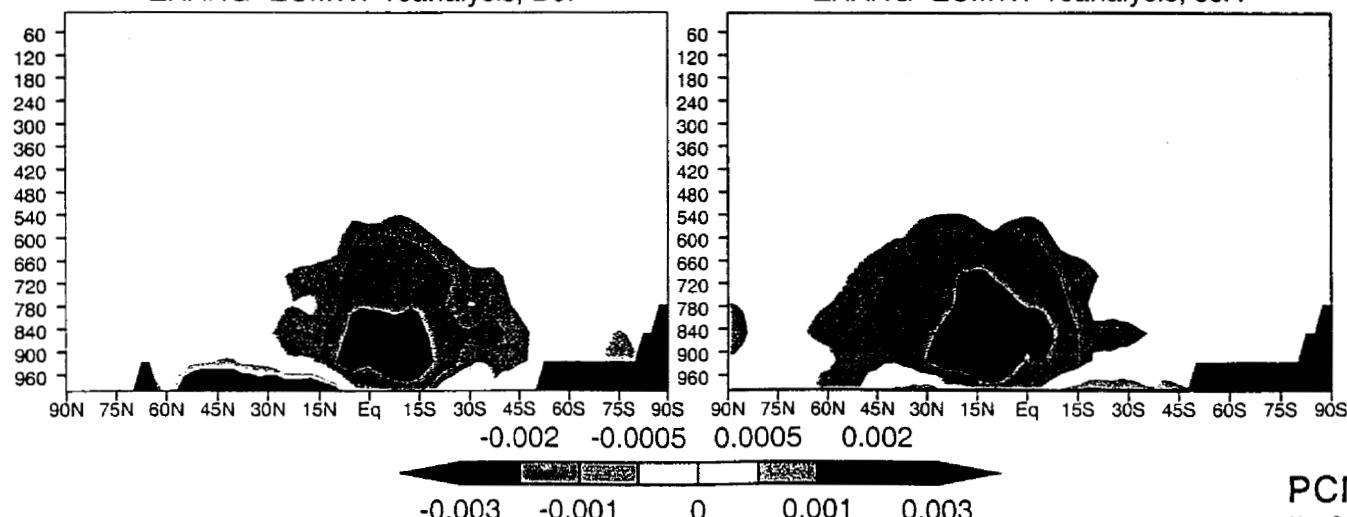
ZHANG DJF



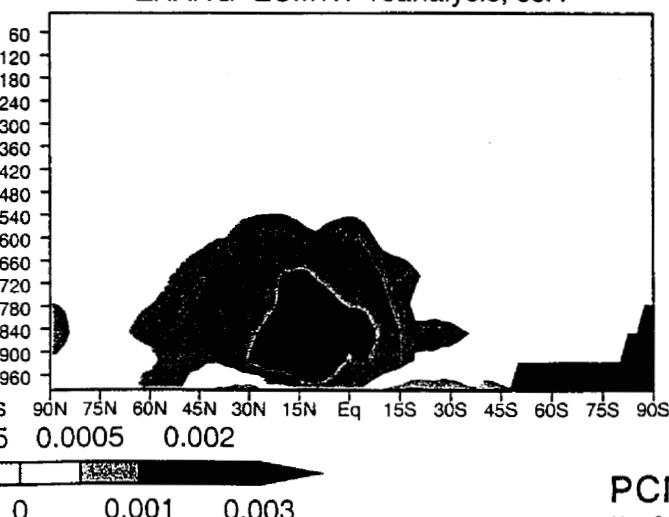
ZHANG JJA



ZHANG- ECMWF reanalysis, DJF

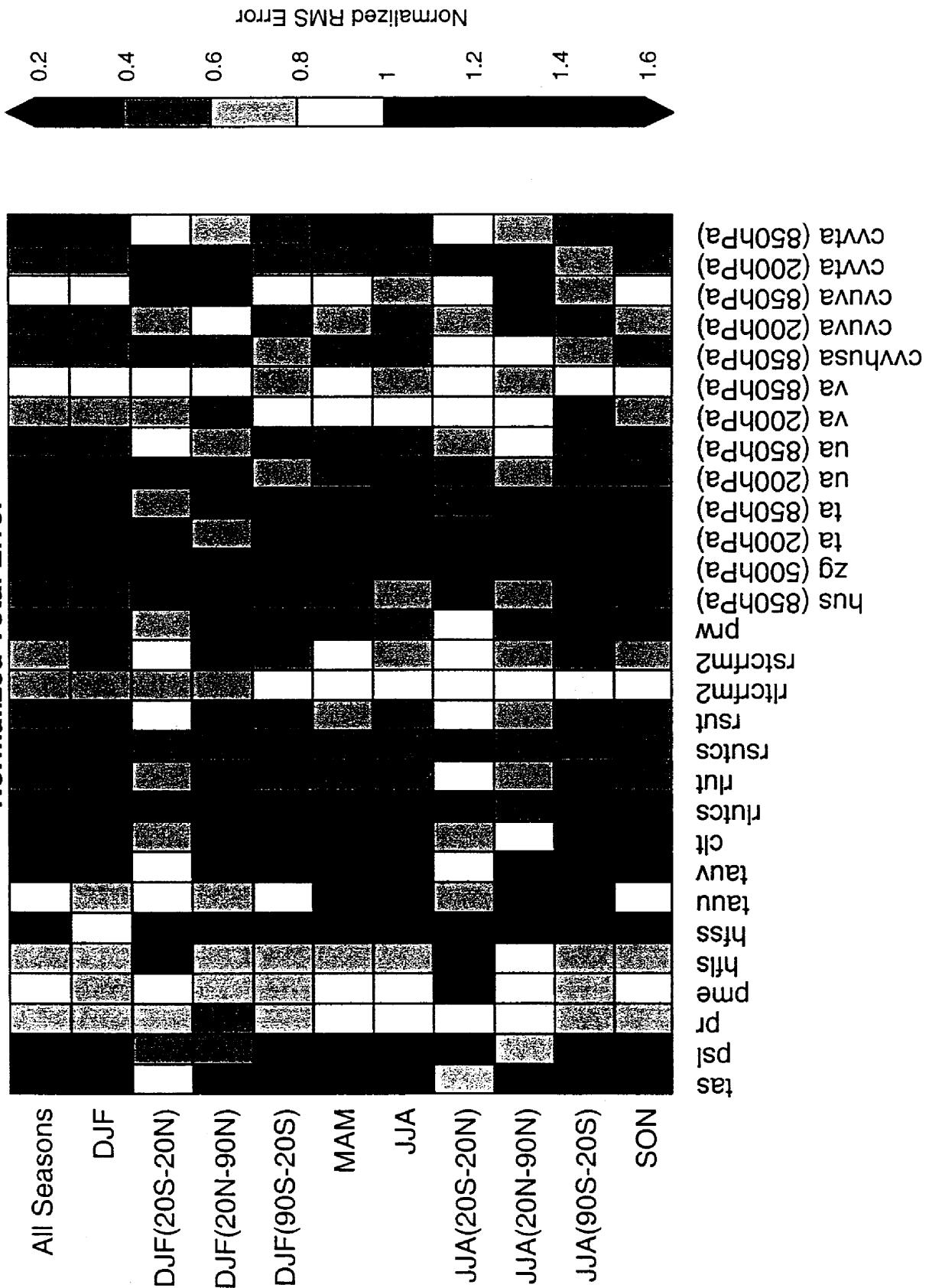


ZHANG- ECMWF reanalysis, JJA



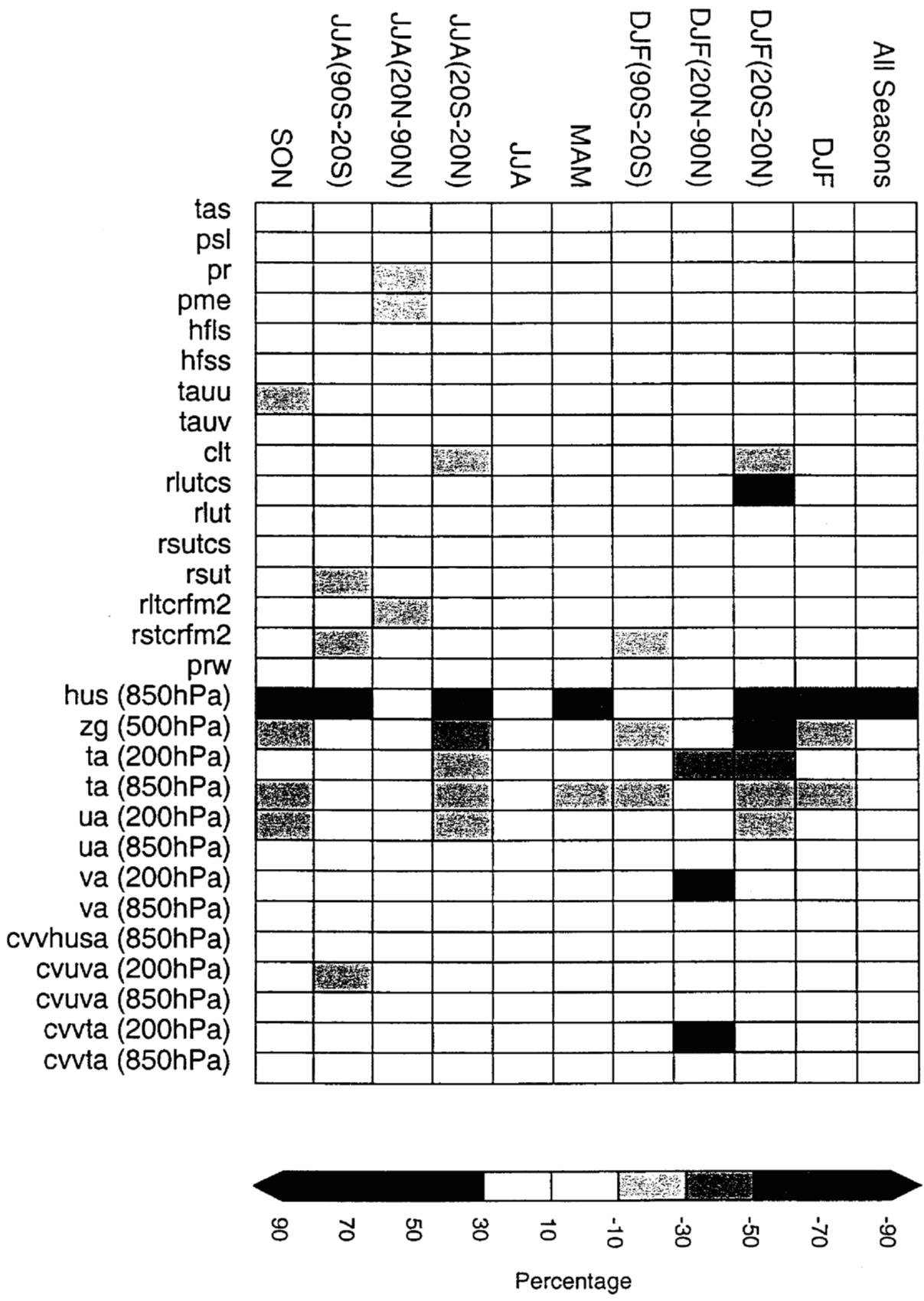
ZHANG

## Normalized Total Error



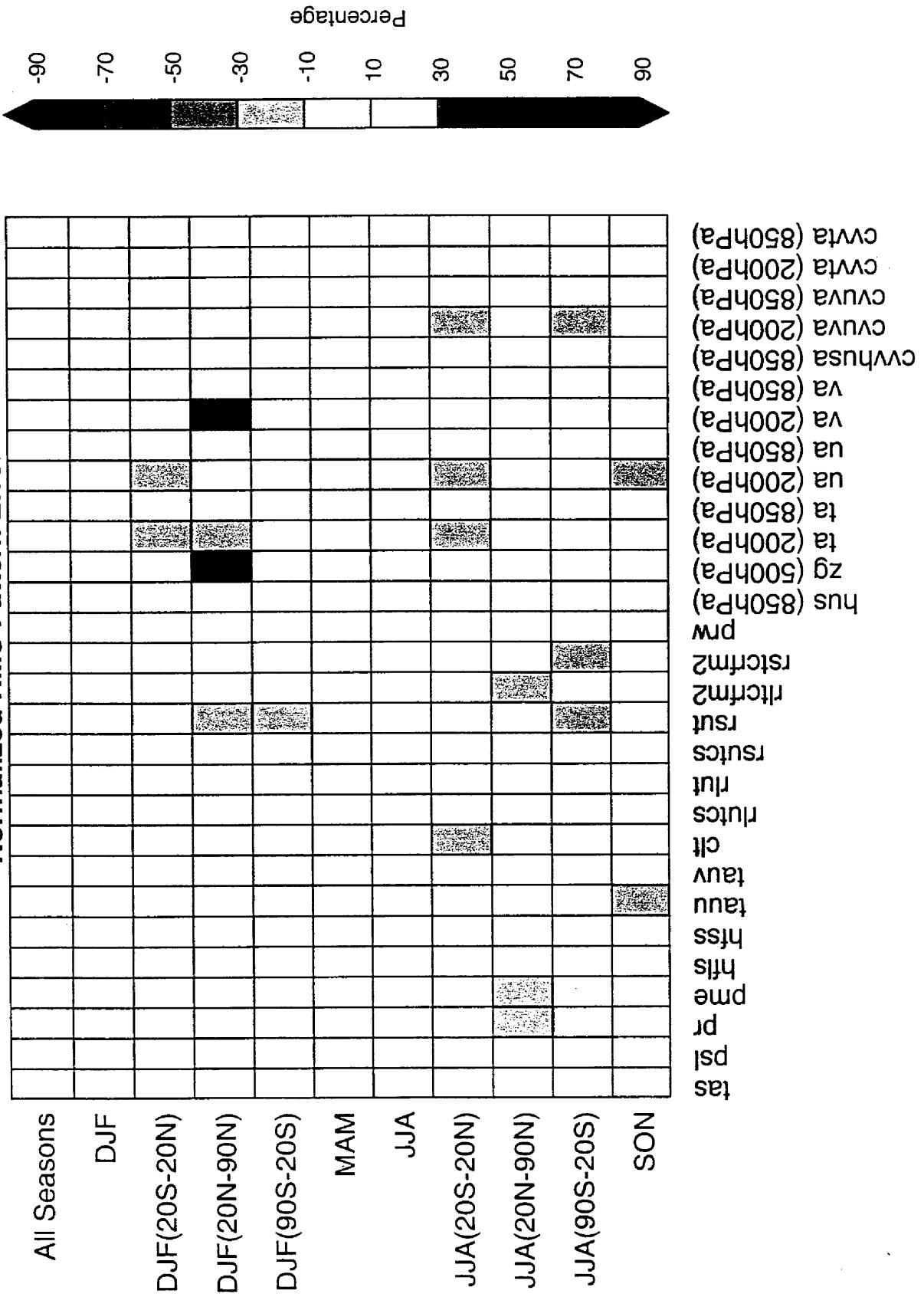
ZHANG: Percentage Difference from CCM3.9.11 (CAM0.1)

**PCMDI**  
Nov 28, 2000



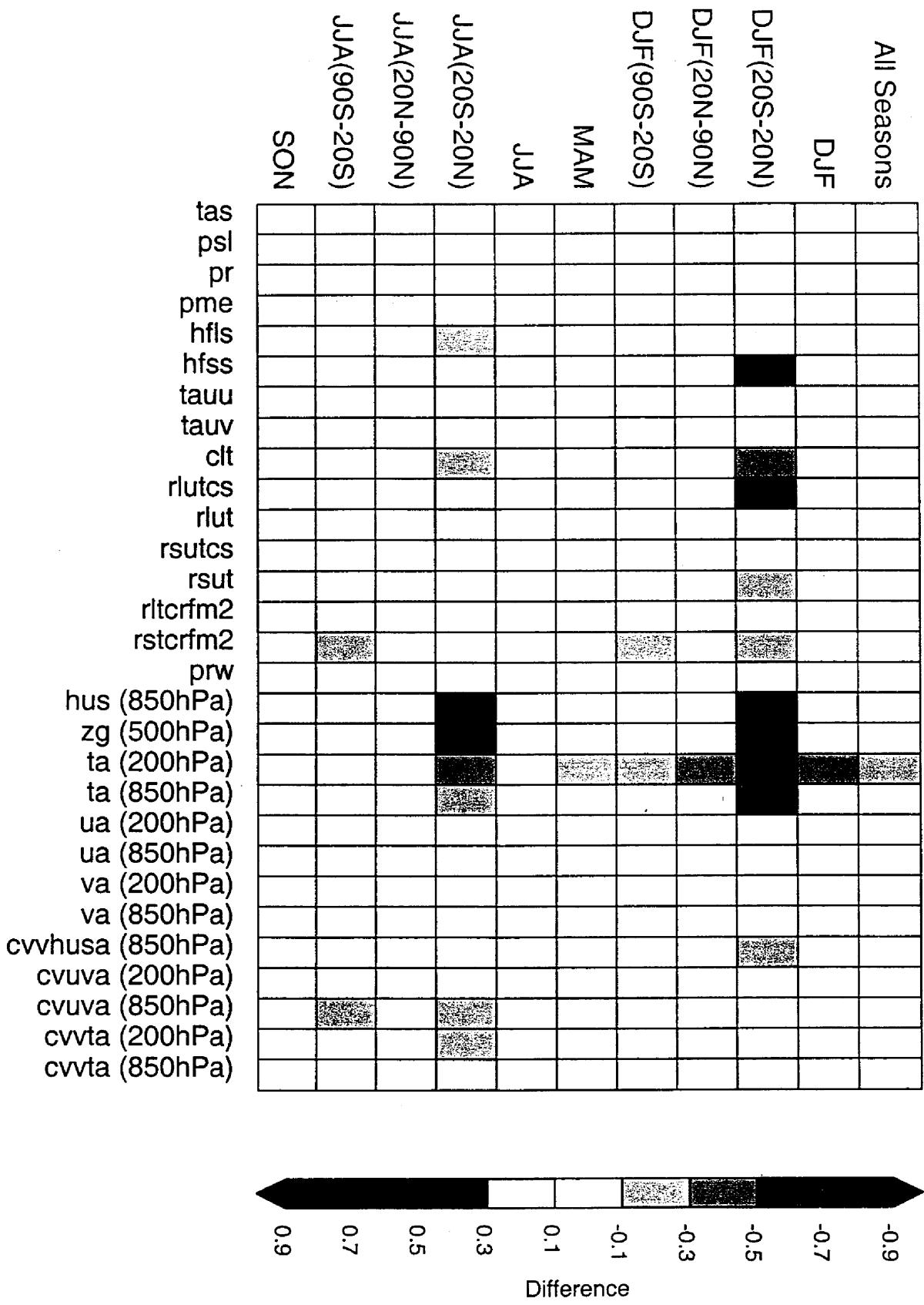
## ZHANG: Percentage Difference from CCM3.9.11 (CAM0.1)

Normalized RMS Pattern Error



ZHANG: Absolute Difference from CCM3.9.11 (CAM0.1)

**PCMDI**  
Nov 28, 2000



# VDT1

- CCM 3.10 physics with vertical diffusion of dry static energy.
- T42, 30 levels
- 5 year climatology run
- no AMIP2 run
- Contact: Byron Boville, NCAR,  
[boville@ucar.edu](mailto:boville@ucar.edu)

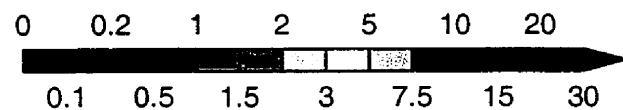
VDT1

Total precipitation rate (mm/day)

Observed (CPC, Xie-Arkin), DJF



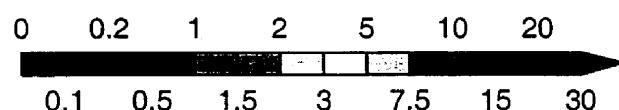
Observed (CPC, Xie-Arkin), JJA



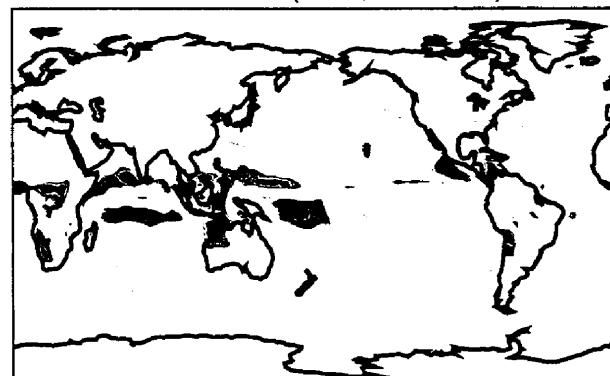
VDT1, DJF



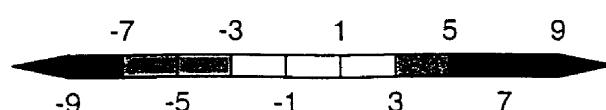
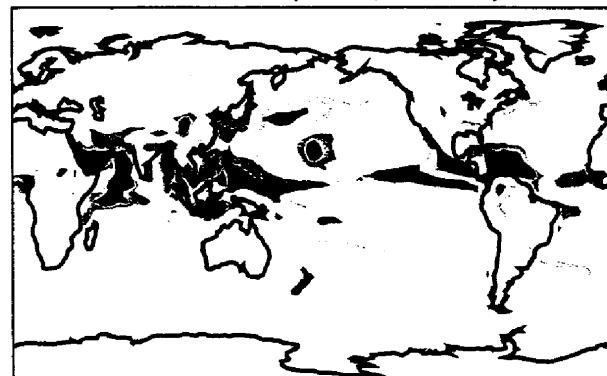
VDT1, JJA



VDT1 - Observed (CPC, Xie-Arkin), DJF



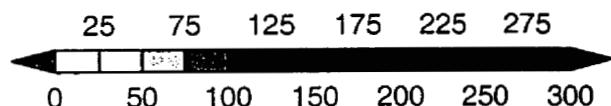
VDT1 - Observed (CPC, Xie-Arkin), JJA



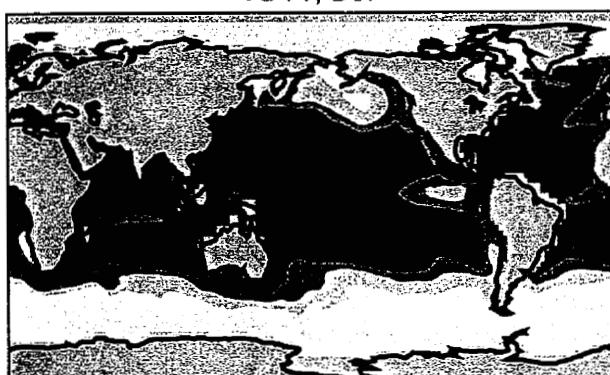
Heat flux latent surface ( $\text{W/m}^2$ )

Observed (COADS), DJF

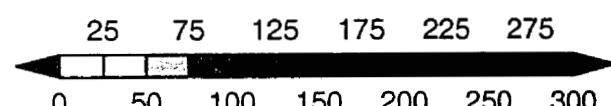
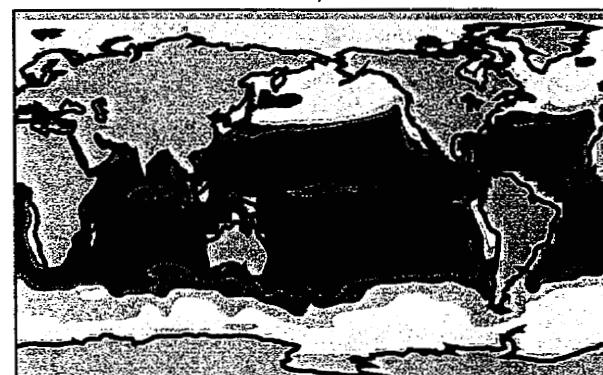
Observed (COADS), JJA



VDT1, DJF



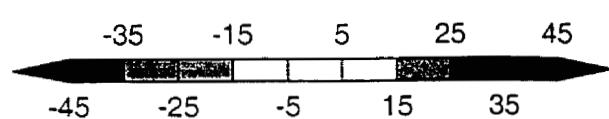
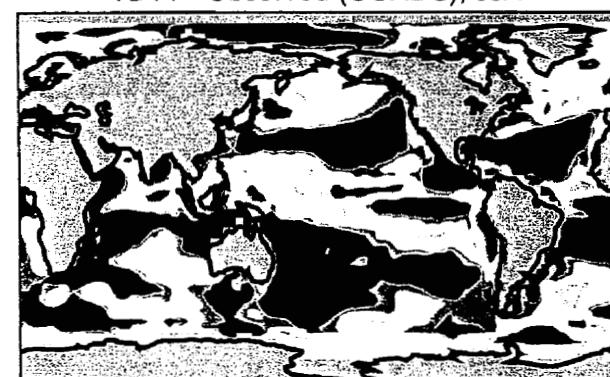
VDT1, JJA



VDT1 - Observed (COADS), DJF



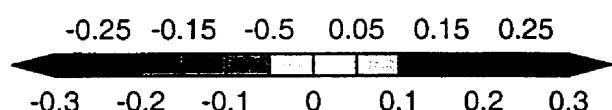
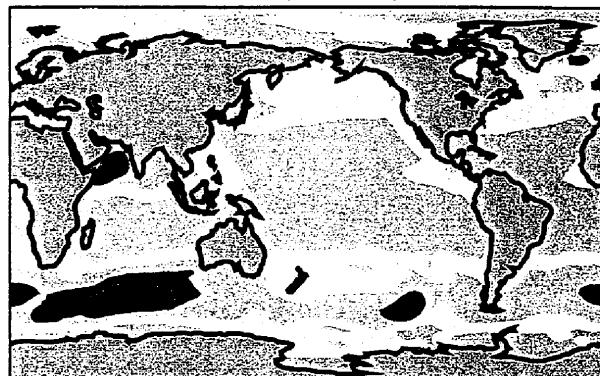
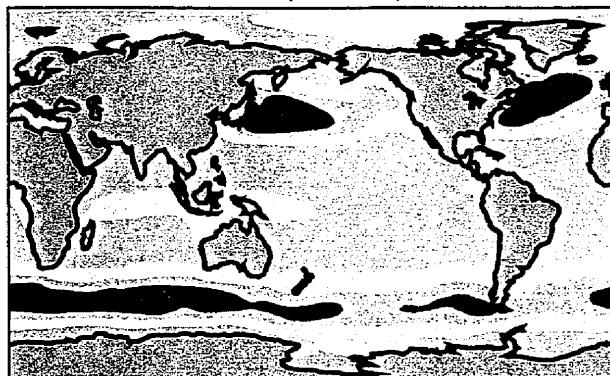
VDT1 - Observed (COADS), JJA



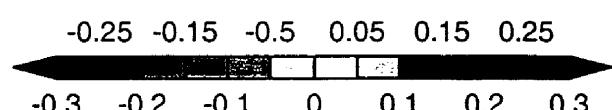
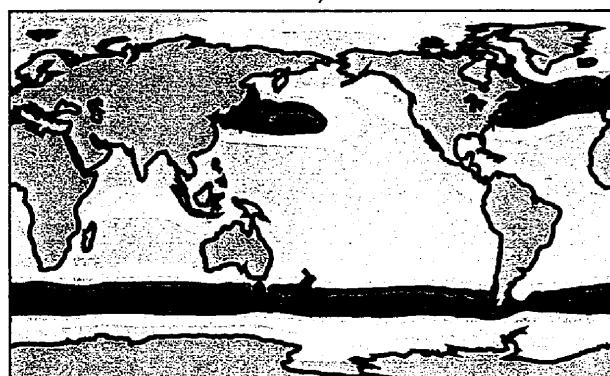
Eastward surface wind stress (positive for eastward wind) ( $N/m^2$ )

Observed (COADS), DJF

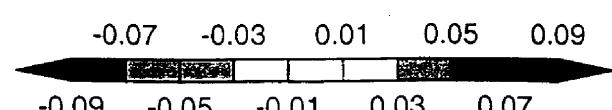
Observed (COADS), JJA



VDT1, DJF



VDT1 - Observed (COADS), DJF

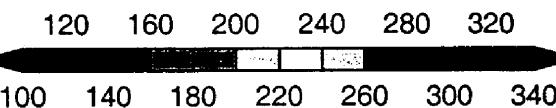


LW radiation TOA (OLR) ( $\text{W/m}^2$ )

Observed (ERBE), DJF



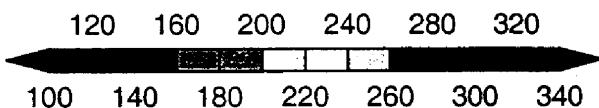
Observed (ERBE), JJA



VDT1, DJF



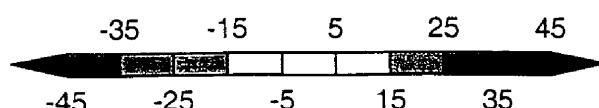
VDT1, JJA



VDT1 - Observed (ERBE), DJF



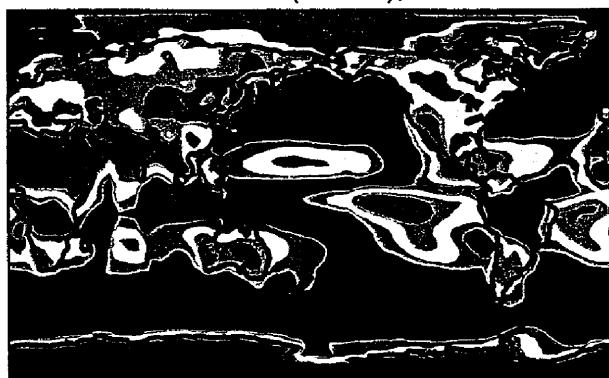
VDT1 - Observed (ERBE), JJA



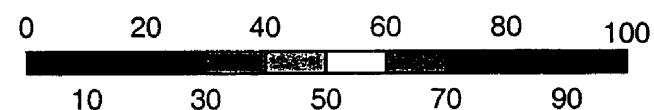
VDT1

Total Cloud Amount (%)

Observed (ISCCP), DJF



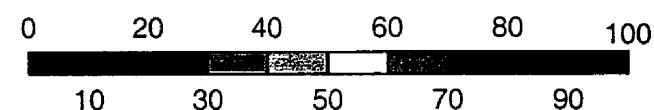
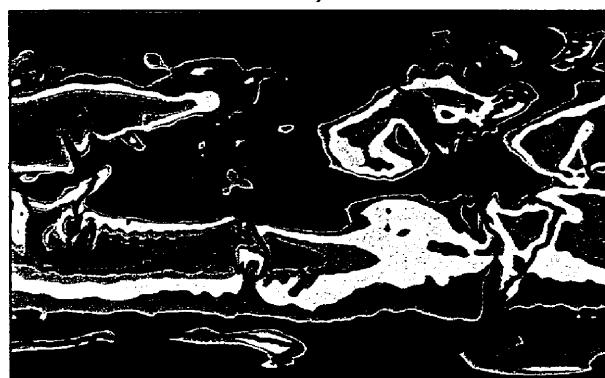
Observed (ISCCP), JJA



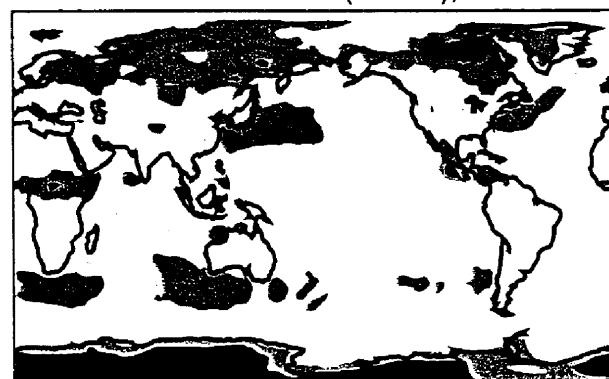
VDT1, DJF



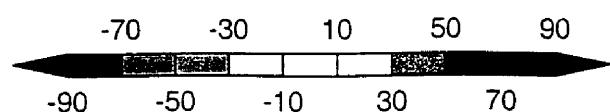
VDT1, JJA



VDT1 - Observed (ISCCP), DJF



VDT1 - Observed (ISCCP), JJA



## Sea Level Pressure (hPa)

Observed (ECMWF Reanalysis), DJF



Observed (ECMWF Reanalysis), JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

VDT1, DJF



VDT1, JJA



975 985 995 1005 1015 1025 1035

970 980 990 1000 1010 1020 1030 1040

VDT1 - Observed (ECMWF Reanalysis), DJF



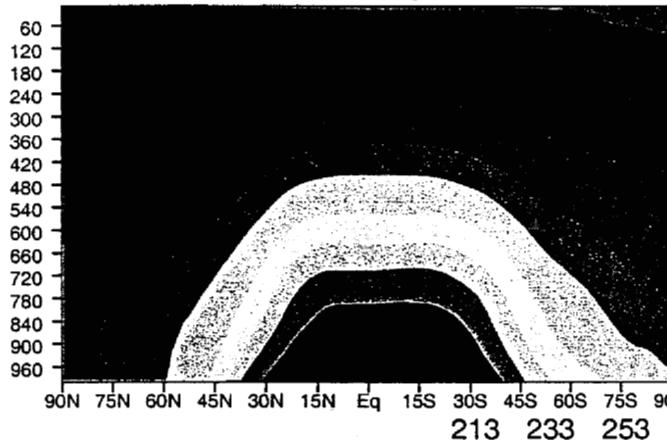
VDT1 - Observed (ECMWF Reanalysis), JJA



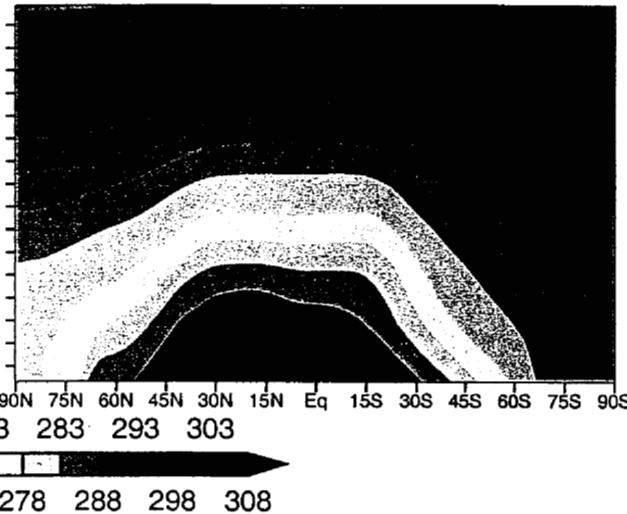
-7 -3 1 5 9  
-9 -5 -1 3 7

## Air Temperature

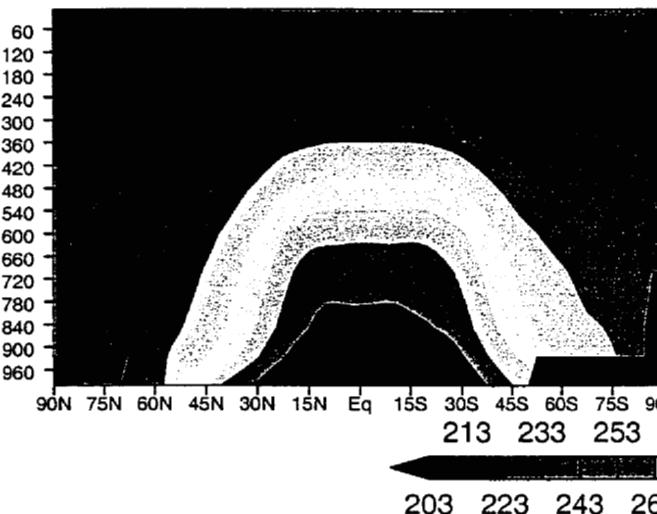
ECMWF reanalysis DJF



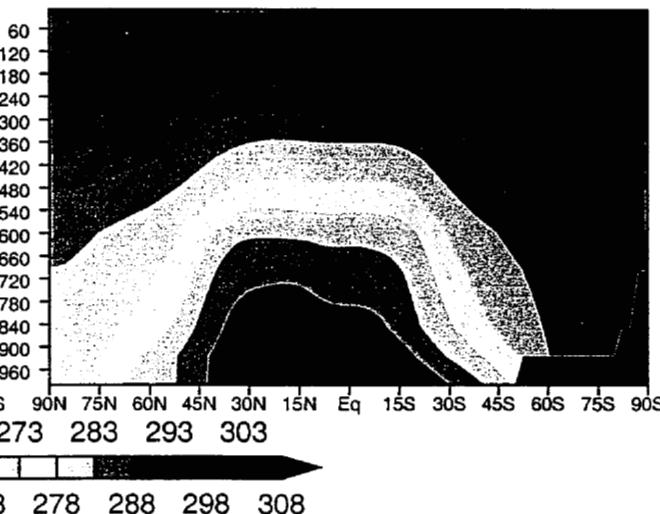
ECMWF reanalysis JJA



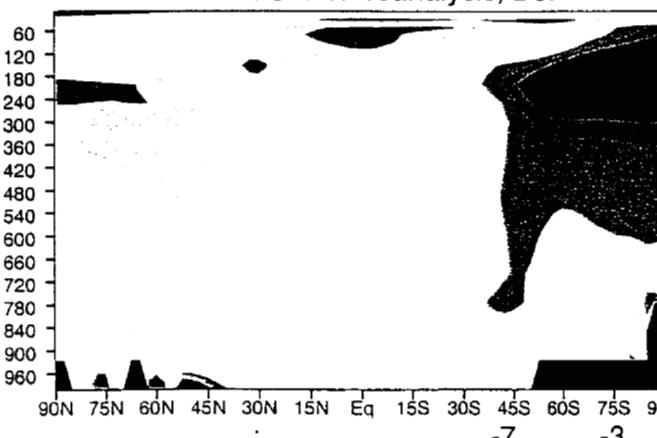
VDT1 DJF



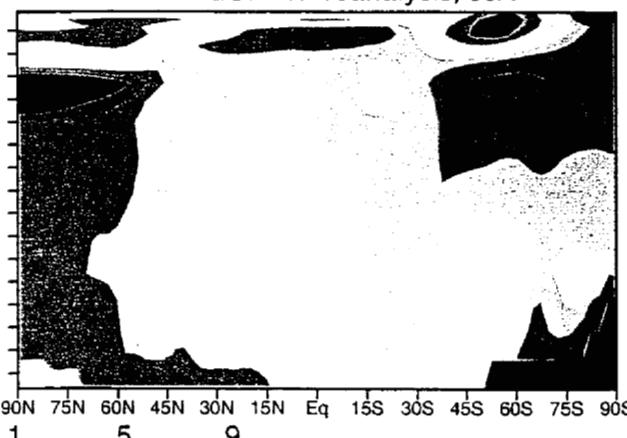
VDT1 JJA



VDT1 - ECMWF reanalysis, DJF

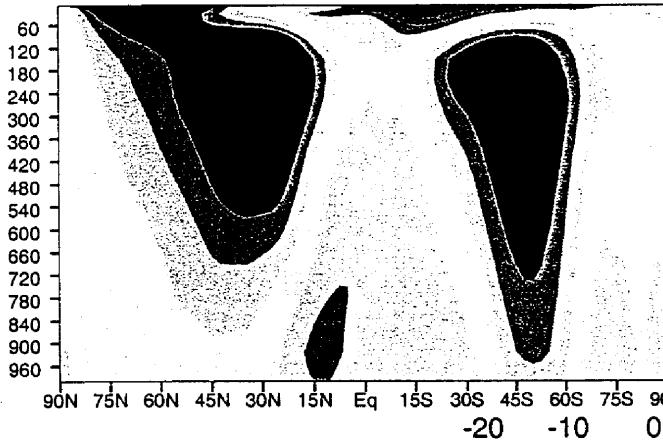


VDT1 - ECMWF reanalysis, JJA

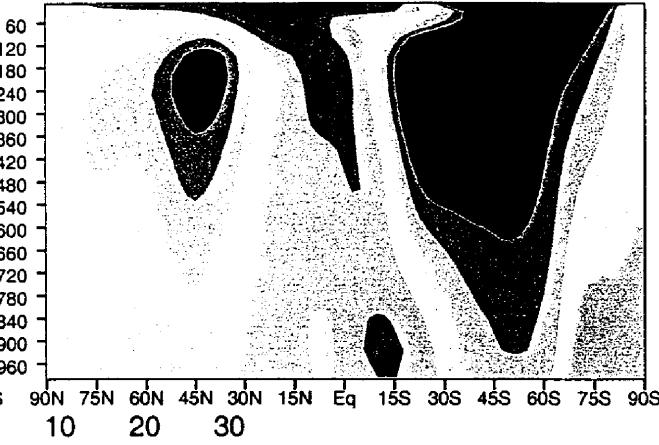


Eastward wind

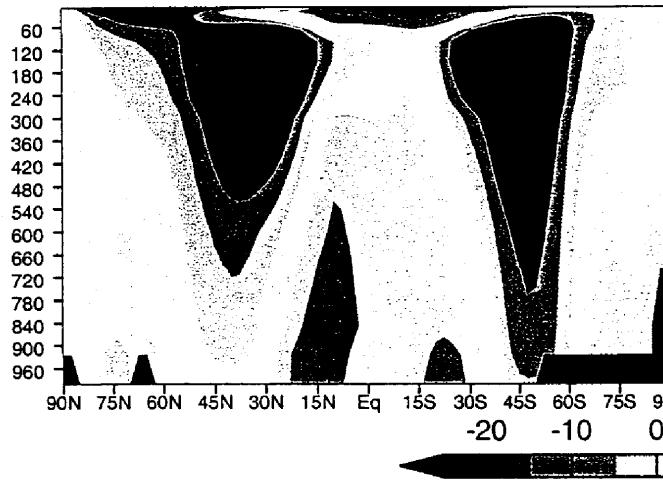
ECMWF reanalysis DJF



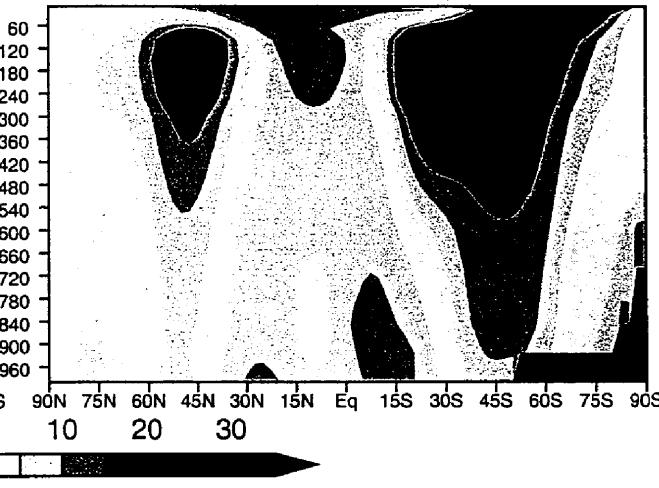
ECMWF reanalysis JJA



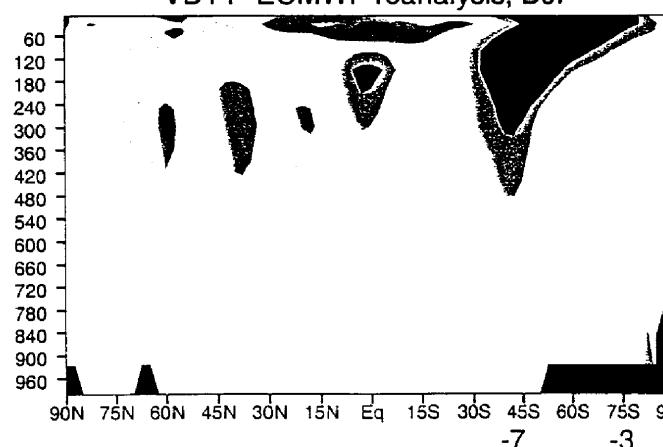
VDT1 DJF



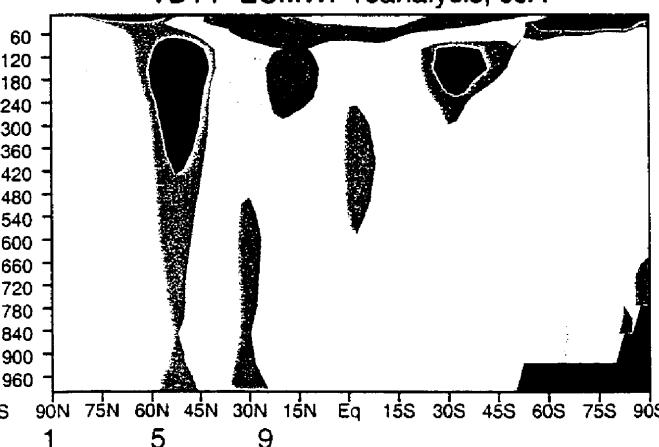
VDT1 JJA



VDT1- ECMWF reanalysis, DJF

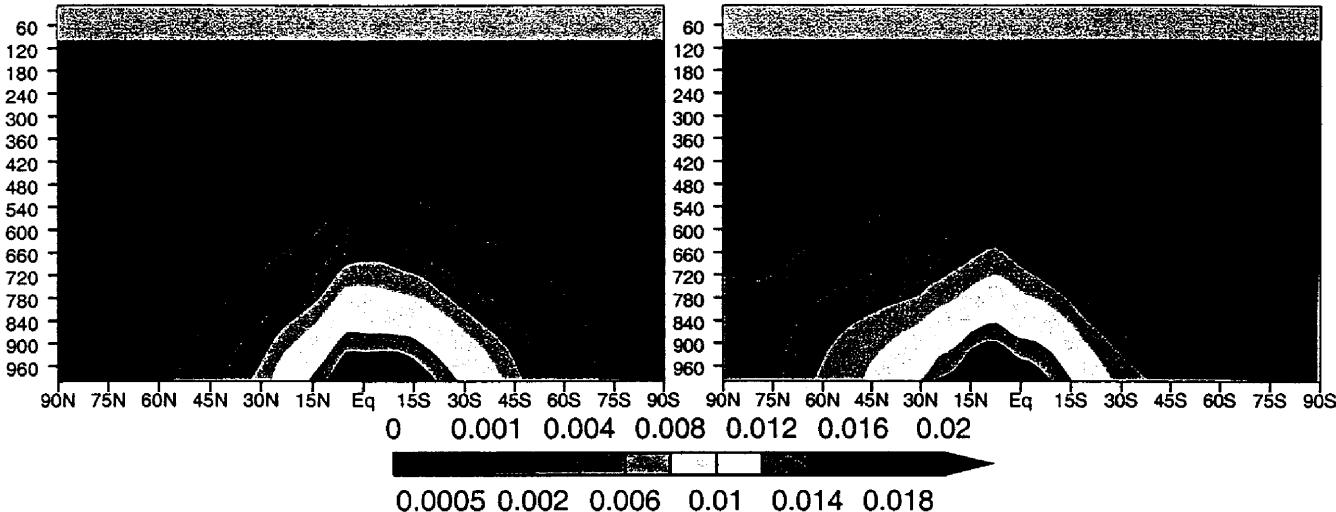


VDT1- ECMWF reanalysis, JJA

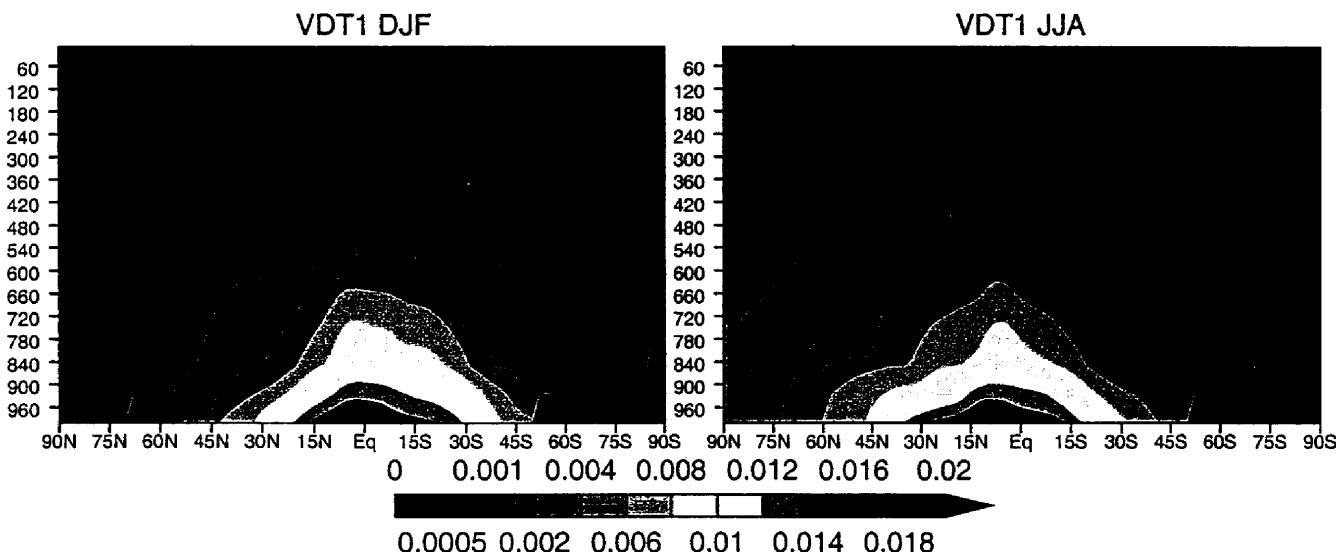


## Specific humidity

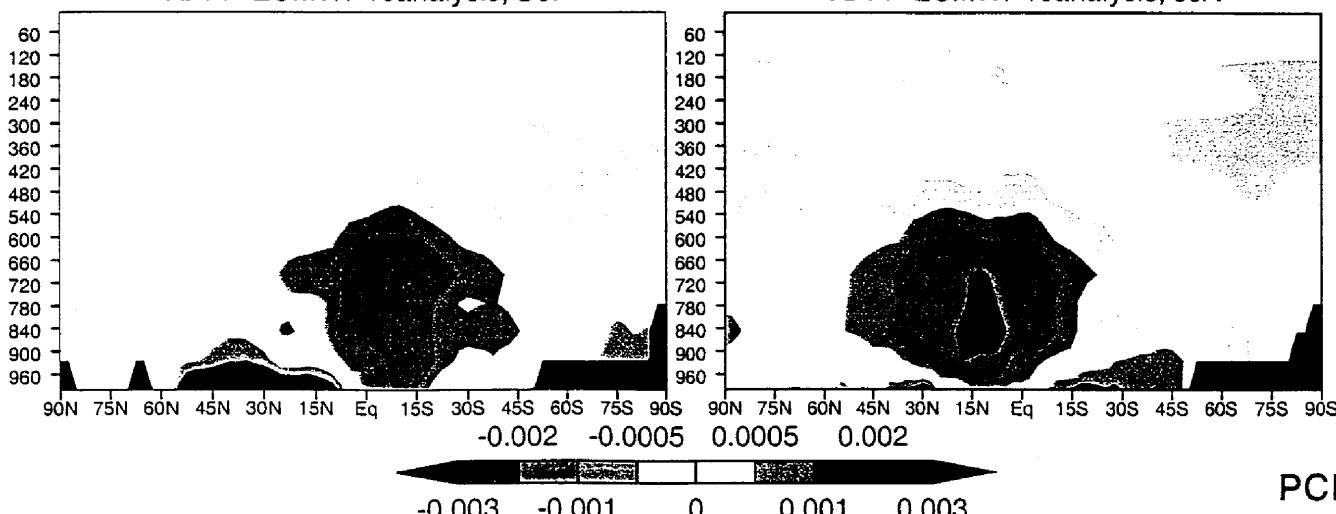
ECMWF reanalysis DJF



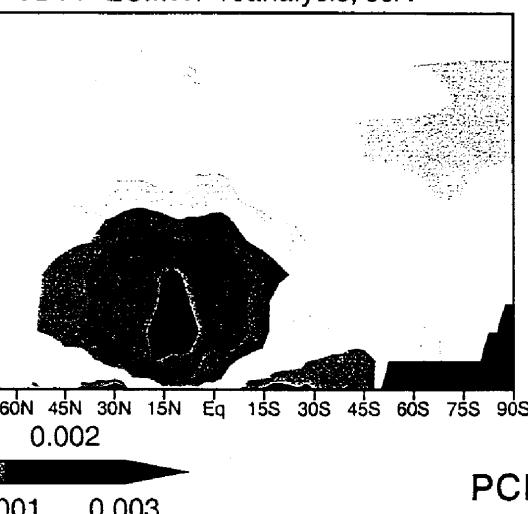
ECMWF reanalysis JJA



VDT1 DJF

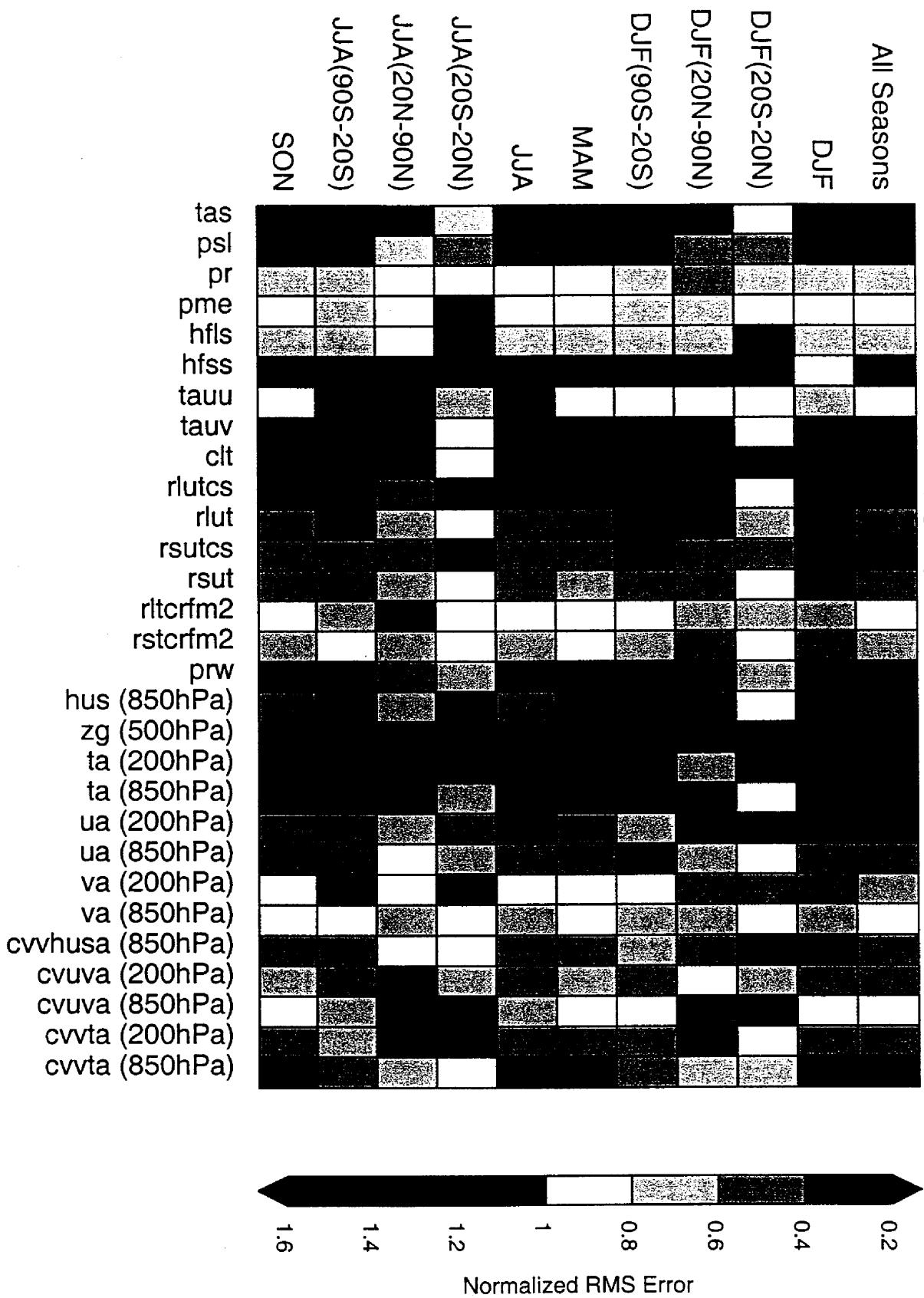


VDT1 JJA



# VDT1

## Normalized Total Error

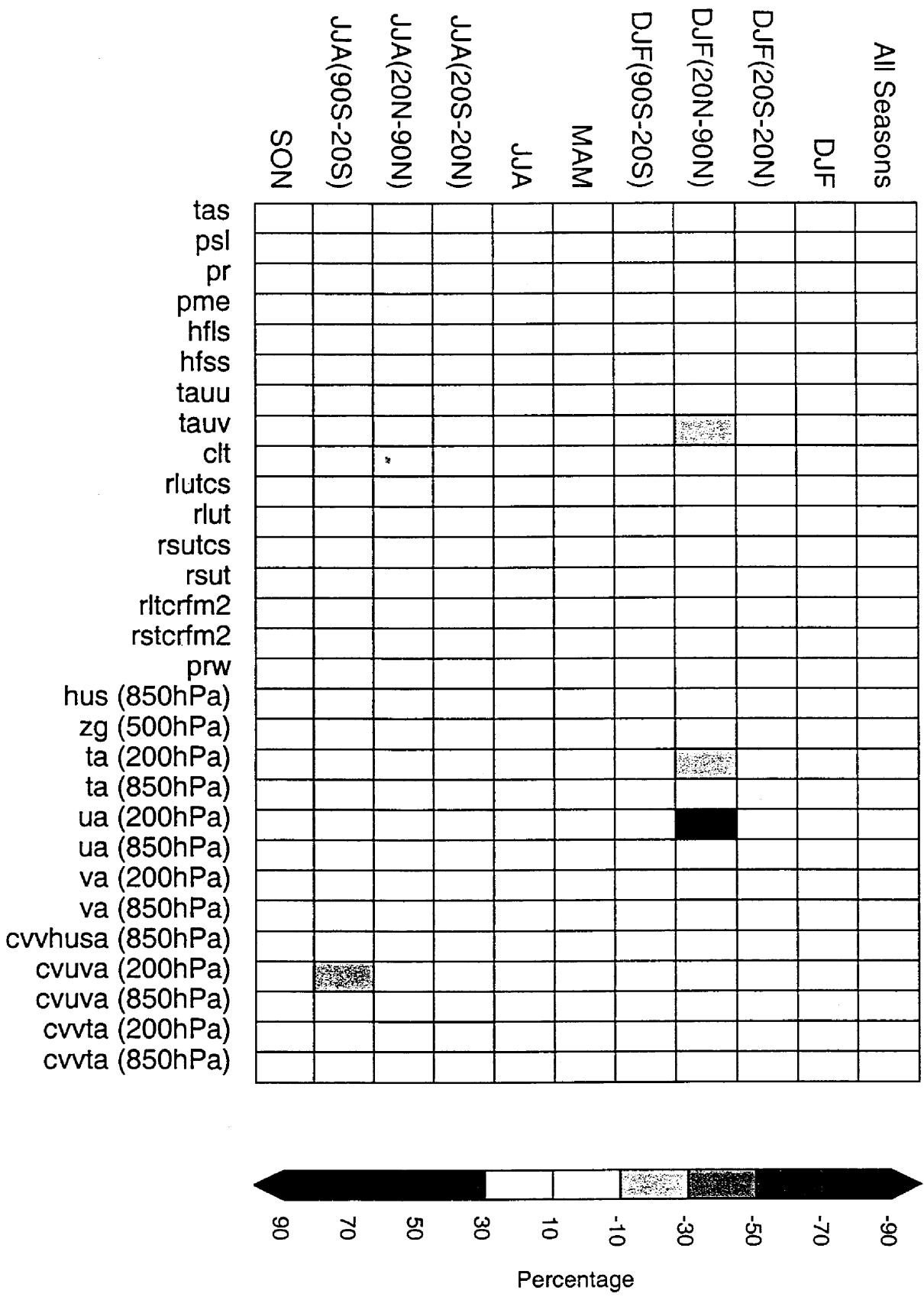


Normalized RMS Error

# VDT1: Percentage Difference from CCM3.9.11 (CAM0.1)

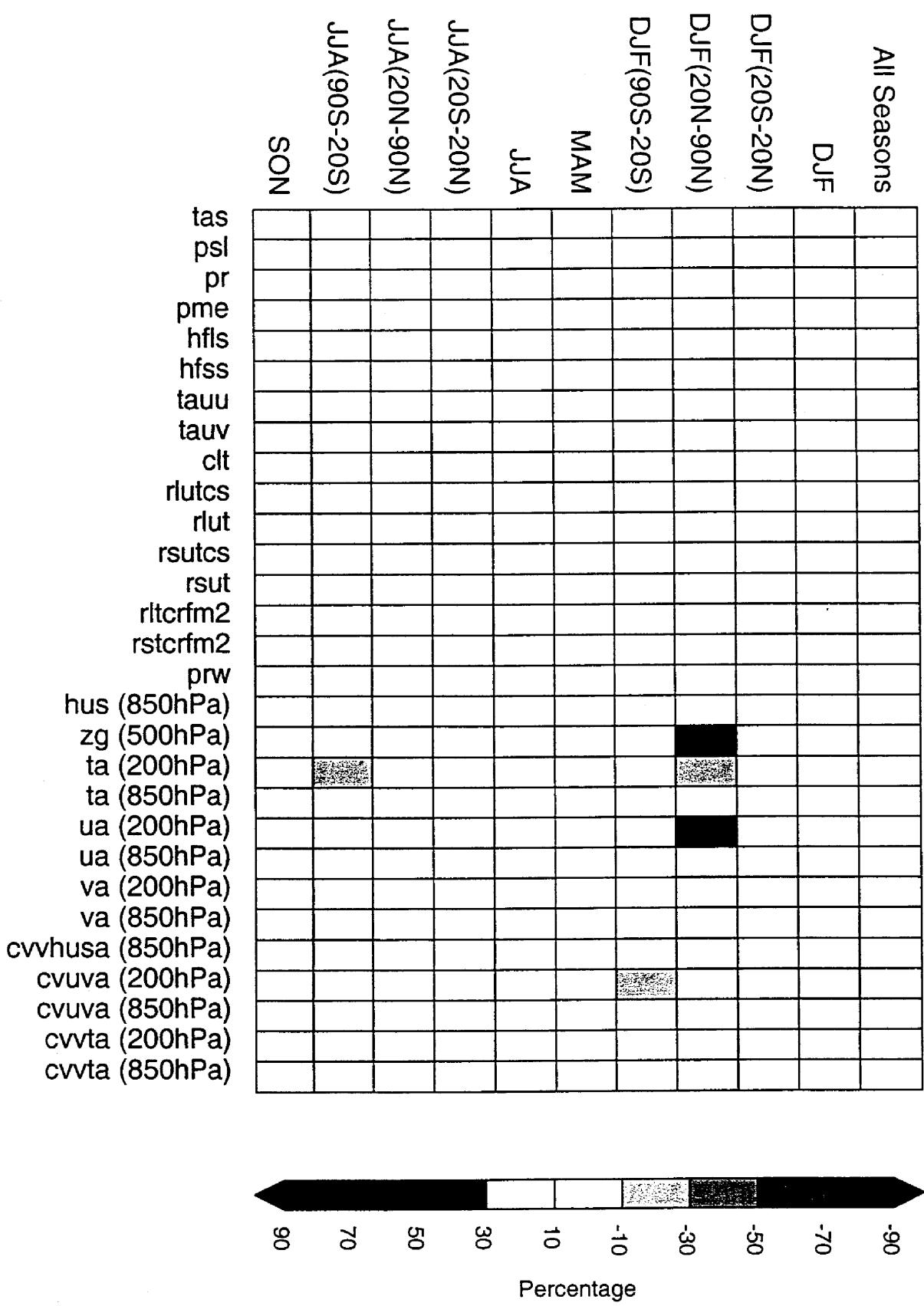
Normalized Total Error

PCMDI  
Nov 28, 2000

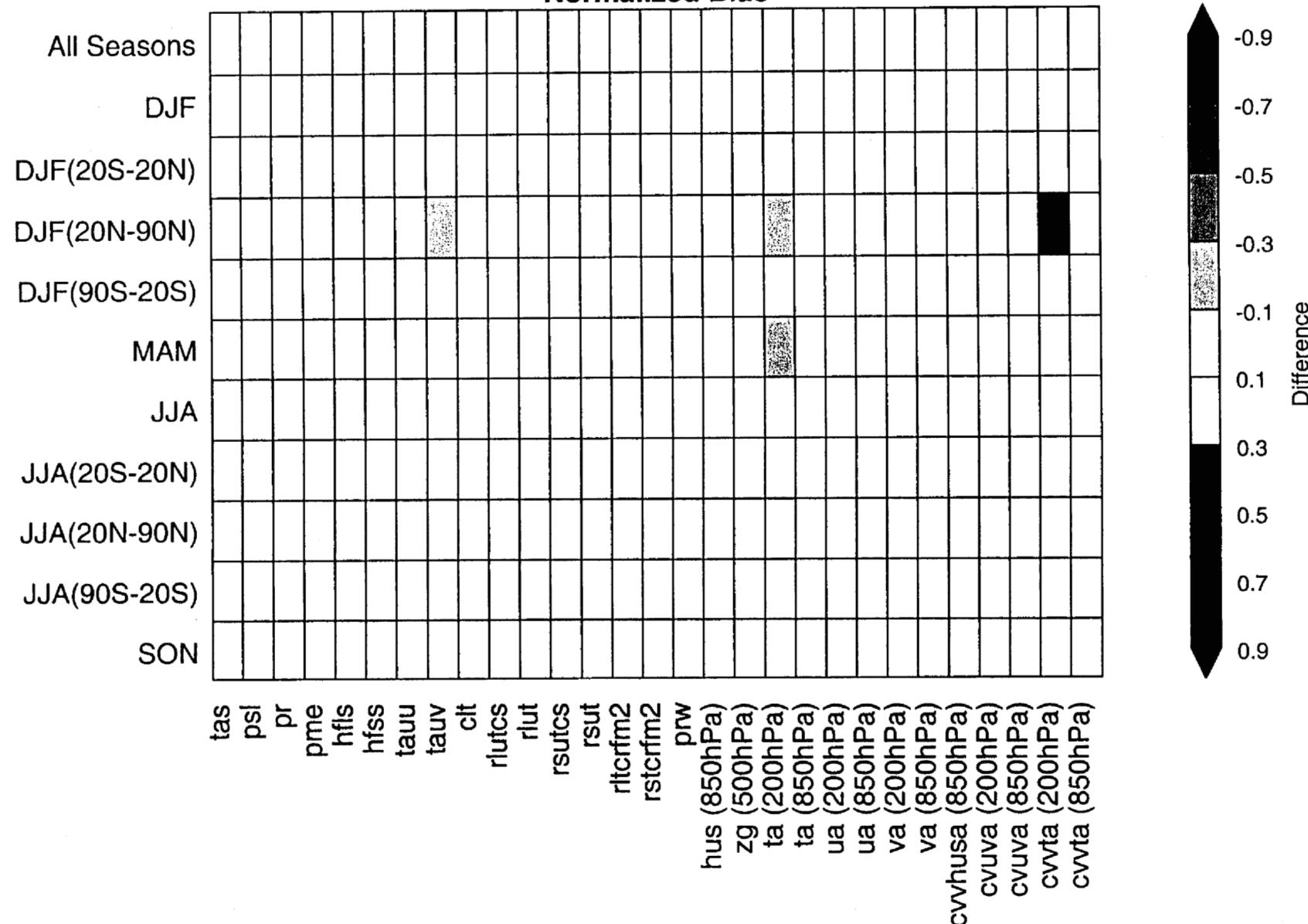


## VDT1: Percentage Difference from CCM3.9.11 (CAM0.1)

**PCMDI**  
Nov 28, 2000



## VDT1: Absolute Difference from CCM3.9.11 (CAM0.1) Normalized Bias



University of California  
Lawrence Livermore National Laboratory  
Technical Information Department  
Livermore, CA 94551

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